

IMPORTANT

This manual obsoletes the similar shop manual data in manuals AC-6, AC-12 and AC-13. If you have AC-6, AC-12 and/or AC-13 destroy them.



ALLIS-CHALMERS

SHOP MANUAL

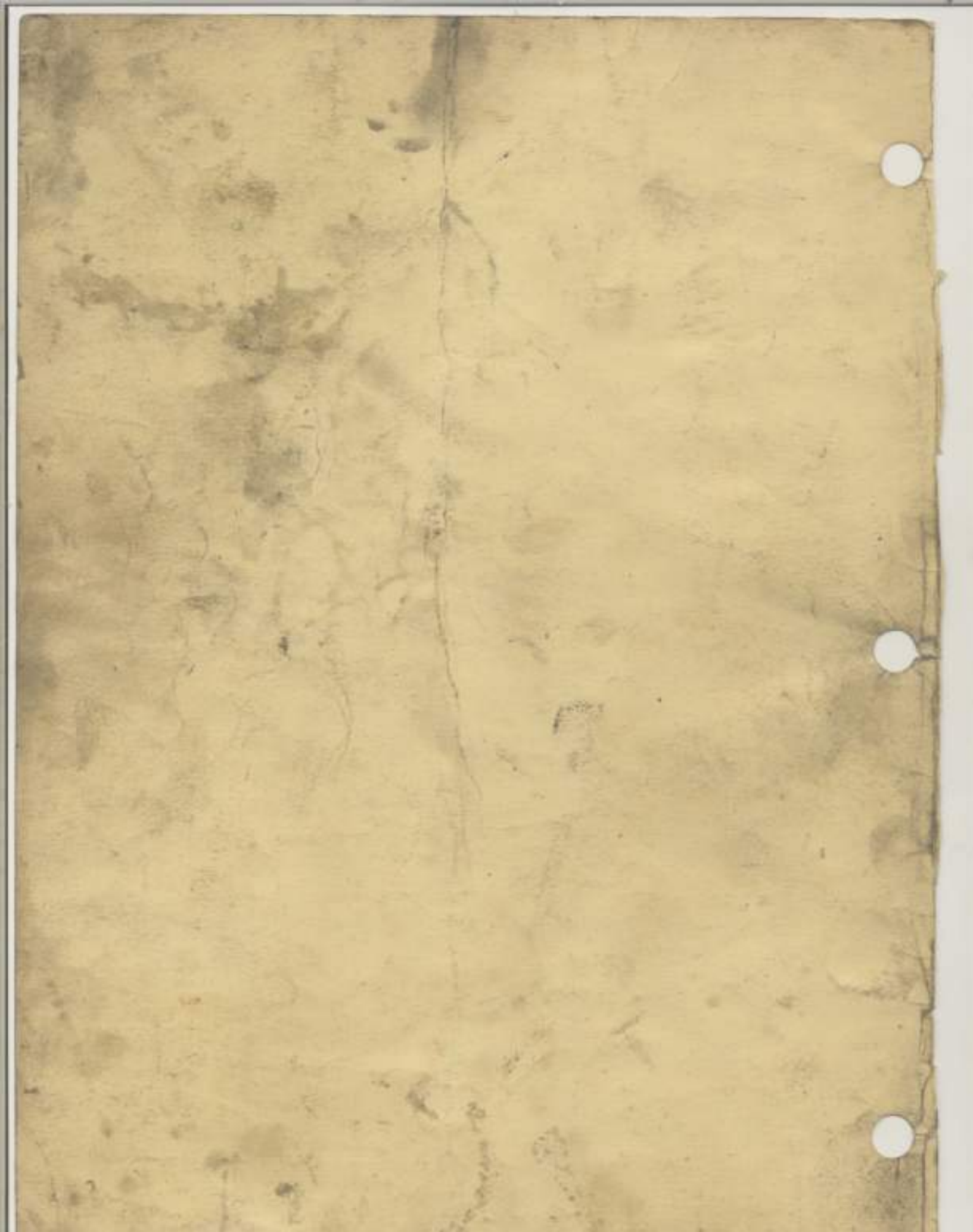
MODELS ■ D-14 ■ D-15 ■ Series II D-15 ■ D-17
■ Series III D-17 ■ Series IV D-17

MANUAL NO. AC-17

KNOWLEDGE
The Measure of a Mechanic



Technical Publications



Information and Instructions

This Individual Shop Manual is one unit of a series on agricultural wheel type tractors. Contained in it are the necessary specifications and the brief but terse procedural data needed by a mechanic when repairing a tractor on which he has had no previous actual experience.

The material is arranged in a systematic order beginning with an index which is followed immediately by a Table of Condensed Service Specifications. These specifications include dimensions, fits, clearances and timing instructions. Next in order of arrangement is the procedures section.

In the procedures section, the order of presentation starts with the front axle system and steering and proceeds toward the rear axle. The last portion of the procedures section is devoted to the power take-off and power lift

systems. Interspersed where needed in this section are additional tabular specifications pertaining to wear limits, torquing, etc.

HOW TO USE THE INDEX

Suppose you want to know the procedure for R&R (remove and reinstall) of the engine camshaft. Your first step is to look in the index under the main heading of ENGINE until you find the entry "Camshaft." Now read to the right where under the column covering the tractor you are repairing, you will find a number which indicates the beginning paragraph pertaining to the camshaft. To locate this wanted paragraph in the manual, turn the pages until the running index appearing on the top outside corner of each page contains the number you are seeking. In this paragraph you will find the information concerning the removal of the camshaft.

I&T SHOP SERVICE

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All instructions and diagrams have been checked for accuracy and ease of application; however, success and safety in working with tools depend to a great extent upon individual accuracy, skill and caution. For this reason the publishers are not able to guarantee the result of any procedure contained herein. Nor can they assume responsibility for any damage to property or injury to persons occasioned from the procedures. Persons engaging the procedures do so entirely at their own risk.

SHOP MANUAL

ALLIS-CHALMERS

**MODELS D-14, D-15, D-15 SERIES II, D-17, D-17 SERIES III
AND D-17 SERIES IV**

Model D-14 tractors were available in single wheel tricycle, dual wheel tricycle and adjustable axle versions with non-diesel engines only.

Model D-15 tractors were available in single wheel tricycle, dual wheel tricycle, adjustable or heavy duty non-adjustable front axle versions with either 175 cubic inch diesel or 149 cubic inch non-diesel engines

Model D-15 Series II tractors are available in single wheel tricycle, dual wheel tricycle, adjustable or heavy duty non-adjustable front axle versions with either 175 cubic inch diesel or 160 cubic inch non-diesel engine.

D-17, D-17 Series III and D-17 Series IV tractors are available in single wheel tricycle, adjustable or heavy duty non-adjustable front axle versions with either 262 cubic inch diesel or 226 cubic inch non-diesel engine.

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CONDENSED SERVICE DATA

| GENERAL | D-14 | D-15 Non-Diesel | D-15 Diesel | D-17 Non-Diesel | D-17 Diesel |
|----------------------------------|-----------------|--------------------|-----------------|--------------------|------------------|
| Engine Make | Own | Own | Own | Own | Own |
| Cylinders | 4 | 4 | 4 | 4 | 0 |
| Bore—Inches | 3 $\frac{1}{2}$ | 3 $\frac{1}{4}$ * | 3 $\frac{1}{2}$ | 4 | 3 $\frac{1}{2}$ |
| Stroke—Inches | 3 $\frac{1}{2}$ | 3 $\frac{1}{4}$ | 4 $\frac{1}{2}$ | 4 $\frac{1}{2}$ | 4 $\frac{1}{2}$ |
| Displacement—Cubic Inches | 149 | 149* | 175 | 226 | 262 |
| Pistons Removed From | Above | Above | Above | Above | Above |
| Main Bearings, Number of | 3 | 3 | 5 | 3 | 7 |
| Main Bearings Adjustable? | No | No | No | No | No |
| Rod Bearings Adjustable? | No | No | No | No | No |
| Cylinder Sleeves | Wet | Wet | Wet | Wet | Wet |
| TUNE-UP | | | | | |
| Firing Order | 1-2-4-3 | 1-2-4-3 | 1-2-4-2 | 1-2-4-3 | 1-5-3-6-2-4 |
| Valve Tappet Gap (Hot) | | | | | |
| Intake | 0.012-0.014 | 0.008-0.010 | 0.010 | 0.012-0.014 | 0.010 |
| Exhaust | 0.012-0.014 | 0.014-0.016 | 0.015 | 0.012-0.014 | 0.013 |
| Valve Seat & Face Angle | | | | | |
| Intake | 45 | 45 | 45 | 30 | See Paragraph 29 |
| Exhaust | 45 | 45 | 45 | 45 | 45 |
| Ignition Distributor Make | D-R | D-R | — | D-R | — |
| Mark Indicating: | | | | | |
| Retarded Timing | "DC" | "Center" | — | See | — |
| Full Advanced Timing | "Fire" | "F-25" | — | Paragraph | — |
| Mark Location | Flywheel | Flywheel | — | 147 | — |
| Breaker Point Gap | 0.022 | 0.022 | — | 0.022 | — |
| Spark Plug Gap | 0.030 | 0.025** | — | 0.025** | — |
| Injection Pump Make | — | — | RoosaMaster | — | RoosaMaster |
| Injection Pump Timing | — | — | See Paragraphs | — | See Paragraphs |
| Compression Pressure at Cranking | | | | | |
| Speed—Gasoline or Diesel | 135 | 160 | 124 and 125 | 145 | 385 |
| Low Idle RPM | 450 | 550 | 625 | 600 | 625 |
| High Idle RPM | 2025 | 2200 | 2200 | 1975 | 1955 |
| Full Load RPM | 1650 | 2000 | 2000 | 1650 | 1650 |

* Series II D-15 engine cylinder bore 3 $\frac{1}{4}$ inches; displacement is 160 cubic inches.

**Spark plug gap for D-15 and D-17 LP-Gas models should be 0.020.

FRONT SYSTEM

SINGLE WHEEL TRICYCLE

1. WHEEL ASSEMBLY. The single front wheel assembly may be removed after raising front of tractor and removing bolts (3—Fig. 1) at each end of front wheel spindle (1).

To renew bearings and/or seals, first remove wheel assembly; then, unbolt and remove bearing retainer (10—Fig. 2), seal (4), seal retainer (5) and shims (9). Drive or press on opposite end of spindle to remove spindle (8), bearing cones (7) and bearing cup from retainer side of hub. Then drive remaining seal and bearing cup out of hub. Remove bearing cones from spindle.

Soak new felt seals in oil prior to installation of seals and seal retainers. Drive bearing cup into hub until cup is firmly seated. Drive bearing cones tightly against shoulders on spindle. Pack bearings with No. 2 wheel bearing grease. Install spindle and bearings in hub and drive remaining bearing cup in against cone. When installing bearing retainer, vary the number of shims (9) to give free rolling fit of bearings with no end play.

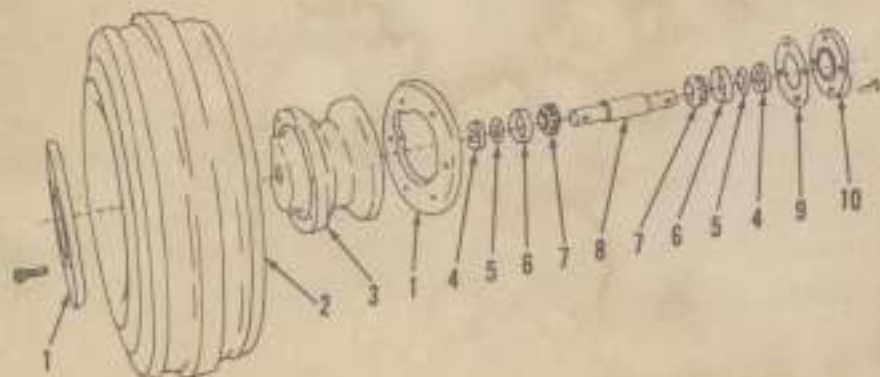


Fig. 2—Exploded view of single front wheel assembly.

- | | | |
|------------------|-----------------------|----------------------|
| 1. Side caps (2) | 4. Seals (2) | 8. Spindle |
| 2. Tire | 5. Seal retainers (2) | 9. Shims |
| 3. Wheel | 6. Bearing cups (2) | 10. Bearing retainer |
| | 7. Bearing cones (2) | |

Front wheel bearings should be repacked with No. 2 wheel bearing grease after each 500 hours of use.

CAUTION: If necessary to renew single front wheel hub or repack tire, completely deflate tire before unbolting tire retaining rings.

2. R&R SINGLE FRONT WHEEL FORK. Remove wheel assembly as outlined in paragraph 1. Then unbolt and remove fork (2—Fig. 1) from steering sector shaft (14—Fig. 8 or Fig. 24).

When reinstalling fork, tighten the retaining cap screws to a torque of 130-140 Ft.-Lbs.

DUAL WHEEL TRICYCLE

3. WHEEL ASSEMBLY. Front wheel and bearing construction on dual wheel tricycle models is of conventional design. Stamped steel wheel disc is reversible on hub. Bearing adjustment is made by tightening retaining nut on spindle until bearings are firmly seated and then backing nut off one castellation and installing cotter pin. Bearings should be repacked with No. 2 wheel bearing grease after each 500 hours of use.

On models D-14, D-15 (prior to Serial No. D15-9001) and D-17 (prior to Serial No. D17-42001), dual wheel pedestal spindles were equipped with

bearing spacers (10—Fig. 3) and seal retainers (11). Install seal retainer (11) and bearing spacer (10) on spindle; install seal retainer (8) in hub with cupped side to bearing. Soak felt seal in oil prior to installing seal in hub.

Models D-15 (after tractor Serial No. D15-9000) and D-17 (after tractor Serial No. D17-42000) have an external lip type seal. The three lips on outside diameter of seal contact a steel wear sleeve that is pressed into the front wheel hub. Install bearing spacer on spindle with flanged edge against shoulder on spindle. Install seal over spacer with crimped edge of seal against spacer flange. Pack wheel bearings with No. 2 wheel bearing grease and install inner cone in cup. Drive wear sleeve into hub with crimped edge of wear sleeve towards bearing.

4. R&R PEDESTAL. Raise front of tractor, then remove cap screws retaining pedestal to front support casting. The splined coupling (6—Fig. 4) will be removed with the pedestal assembly.

When reinstalling pedestal, hold steering wheel in the center (straight ahead) position and install pedestal with wheels in straight ahead position (caster to rear).



Fig. 1—Exploded view of single front wheel fork and associated parts.

- | | |
|--------------|---------------|
| 1. Spindle | 4. Mud shield |
| 2. Fork | 5. Pin |
| 3. Bolts (2) | |

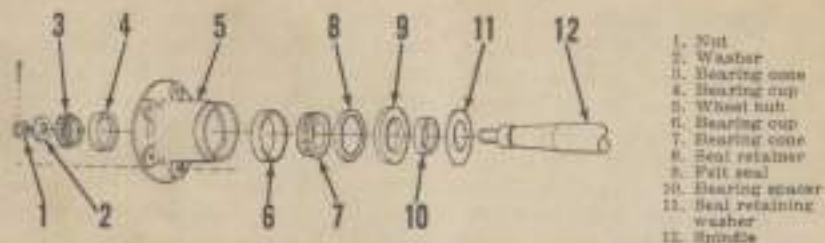


Fig. 3—Exploded view of front wheel hub assembly used on dual front wheel tricycle models. Wide front axle models are similar except spacer (10) and washer (11) are not used.

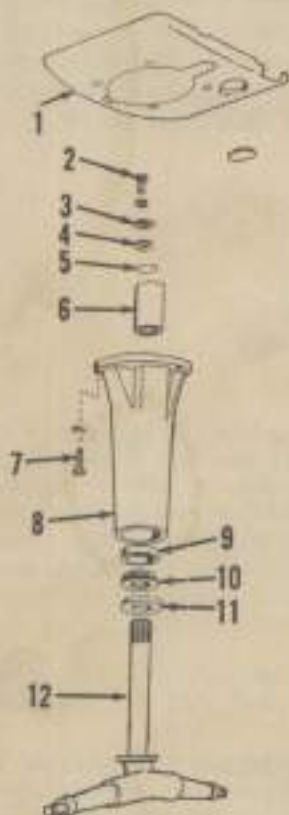


Fig. 4—Exploded view of typical pedestal and associated parts.

- | | |
|------------------|--------------------|
| 1. Mud shield | 2. Cap screw |
| 2. Cap screw | 3. Washer |
| 3. Washer | 4. Shim |
| 4. Shim | 5. Snap ring |
| 5. Snap ring | 6. Spline coupling |
| 7. Mud shield | 8. Pedestal |
| 8. Pedestal | 9. Bearing cup |
| 9. Bearing cup | 10. Bearing cone |
| 10. Bearing cone | 11. Oil seal |
| 11. Oil seal | 12. Spindle shaft |

5. OVERHAUL. To overhaul the removed unit, remove cap screw (2—Fig. 4), washer (3), shims (4) and coupling (6). NOTE: Make certain that shims (4) are not lost or damaged as they provide the proper bearing adjustment. With splined coupling removed, spindle shaft can be withdrawn from pedestal. Pack bearing (10) with No. 2 wheel bearing grease. Oil seal (11) is of the lip type and should be installed with lip towards bearing. Coupling should be installed on spindle shaft with end of coupling nearest internal snap ring downward. When reassembling, vary the number of shims (4) to provide shaft with a free rolling fit and no end play.

WIDE FRONT AXLE

NOTE: D-15 and D-17 models may be equipped with either a standard or heavy duty adjustable front axle or a heavy duty non-adjustable wide front axle. Servicing procedures are similar for all wide front axle models.

6. WHEEL ASSEMBLY. Front wheel and bearing construction on wide front axle models is of conventional design. Stamped steel wheel disc is reversible on hub. Bearing adjustment is made by tightening retaining nut on spindle until bearings are firmly seated; then, backing out off one castellation and installing cotter pin. Bearings should be repacked with No. 2 wheel bearing grease after each 500 hours of use.

On models D-14, D-15 (prior to tractor Serial No. D15-9001) and D-17 (prior to tractor Serial No. D17-42001), a felt type seal was used in front wheel hubs. Install seal retainer (8—Fig. 3) in hub with cupped side of

retainer towards bearing. Soak felt seal in oil prior to installing in hub. Bearing spacer (10) and retainer (11) are not used on wide front axle models.

A lip-type seal is used in the front wheel hubs on D-15 models (after Serial No. D15-9000) and D-17 models (after Serial No. D17-42000). The three lips on outside diameter of seal contact a steel wear sleeve that is pressed into the wheel hub. Install the seal over spindle with crimped edge of seal against shoulder on spindle. Pack wheel bearings with No. 2 wheel bearing grease and install inner cone in cup. Drive the wear sleeve into hub with crimped edge of sleeve towards bearing.

7. ADJUSTMENTS. Front wheel toe-in should be checked after each tread width adjustment on adjustable front axle models. All wide front axle models are provided with toe-in alignment marks; however, it is advisable to measure front wheel toe-in and adjust to 1/16-1/8 inch if necessary. Be sure that tie rod clamps are securely tightened.

8. REMOVE AND REINSTALL. Support tractor, and disconnect tie rods from center steering arm (27—Fig. 5). Detach radius rod pivot bracket (24) from torque tube and lower rear of radius rod. NOTE: Some rear pivots may be different from type shown in Fig. 5. Move front axle assembly rearward and roll axle assembly away from tractor. Axle sup-

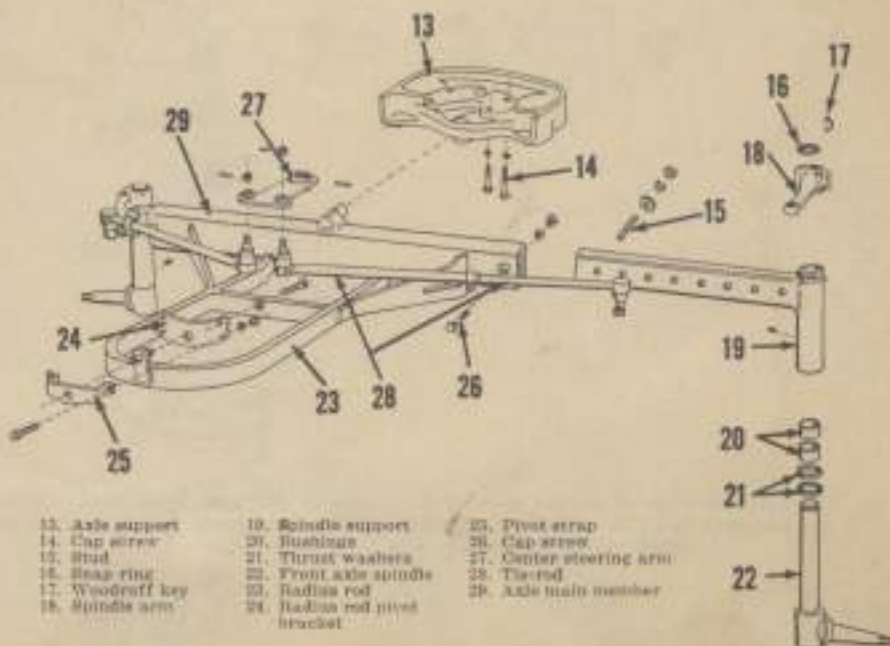


Fig. 5—Exploded view of typical adjustable axle and associated parts. Radius rod (23) is welded to axle main member (29).

port (13) can be removed from the front support after removing the attaching cap screws (14). Center steering arm is attached to steering shaft with a roll pin.

STEERING KNUCKLES (SPINDLES)

9. The procedure for removing the spindles is evident after an examination of the unit and reference to Fig. 5. Bushings (20) should be installed flush with spindle support (19). These bushings are pre-sized and if carefully installed will need no reaming. Tie-rod length should be varied to provide a toe-in of 1/16-1/8 inch.

FRONT SPLIT

Detaching (splitting) the front wheels and steering gear assembly from the tractor is a partial job required in several other jobs such as removing the timing gear cover.

13. To detach (split) the front wheels and steering gear assembly from tractor, first remove the grille and both hood side panels. Drain the coolant from radiator and disconnect the upper and lower radiator hoses. Disconnect tubes from oil cooler on shuttle clutch equipped models. Disconnect wiring to headlamps if mounted on radiator shell. Unbolt the hood center channel from radi-

ator shell, radiator from front support casting and the radiator shell from side rails. Remove the front support breather, then lift the radiator and radiator shell from tractor as a unit. On tractors equipped with power steering, remove the pump inlet (suction) line, the pump to control valve pressure line and the by-pass line. On all models, support the tractor under the torque tube and unbolt the front support from the side rails. On wide front axle models, disconnect the radius rod from its pivot bracket. On all models, roll the complete front assembly away from tractor.

MANUAL STEERING SYSTEM

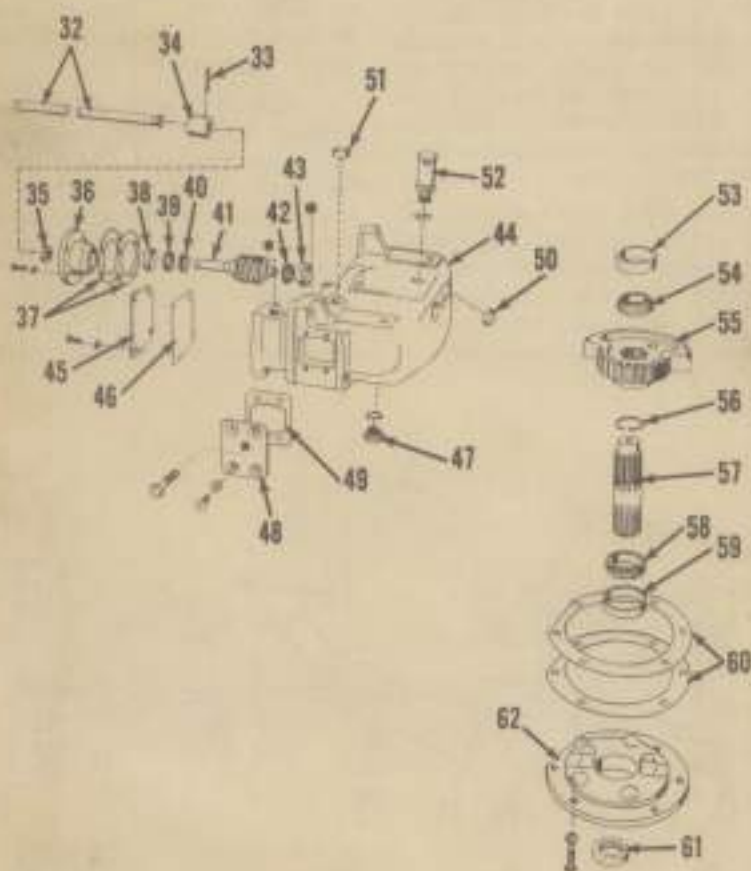


Fig. 7—Exploded view of manual steering front support and associated parts. Shims (37) are available in 0.005 vellum or steel; shims (60) are available in either vellum or steel, vellum being 0.005 and steel 0.010 thick.

- | | | | |
|----------------------|-------------------|-------------------|---------------------------|
| 32. Steering shaft | 40. Bearing cone | 48. Cover | 54. Snap ring |
| 33. Roll pin | 41. Steering worm | 49. Gasket | 55. Steering shaft |
| 34. Splined coupling | 42. Bearing race | 50. Plug | 56. Bearing cone |
| 35. Oil seal | 43. Bearing cap | 51. Plug | 57. Bearing cup |
| 36. Bearing retainer | 44. Front support | 52. Breather | 58. Shims (0.005 & 0.010) |
| 37. Shims (0.005) | 45. Gasket | 53. Bearing cap | 59. Oil seal |
| 38. Bearing cup | 46. Gasket | 60. Oil seal | 61. Shaft retainer |
| 39. Bearing | 47. Drain plug | 62. Steering gear | |

The worm and sector type manual steering gear unit is contained in the front support casting (44—Fig. 7). Recommended steering gear lubricant is SAE 80 EP gear lube. Capacity is approximately 3¼ quarts. Oil level should be maintained at top of steering (sector) gear.

14. **ADJUSTMENT.** The gear unit is provided with two adjustments as follows:

WORMSHAFT BEARINGS. To adjust the steering wormshaft bearings, remove the front support as outlined in paragraph 13 and proceed as follows: Unbolt and remove bearing retainer (36—Fig. 7) and vary the number of shims (37) to remove all shaft end play without causing any binding tendency. Alternate paper and steel shims for proper sealing.

STEERING SHAFT BEARINGS. Support front end of tractor. On single wheel tricycle models, unbolt and remove fork (2—Fig. 1) and wheel assembly from steering sector shaft (14—Fig. 8). On dual wheel tricycle models, unbolt pedestal from steering shaft bearing retainer. On all wide front axle models, unbolt front axle support from front support (steering gear unit); then, raise front of tractor so that front axle support can be removed. Drain oil from front support on all models.

On single wheel tricycle models, refer to Fig. 8 and proceed as follows: Unbolt retainer (9) from bottom of front support and remove re-

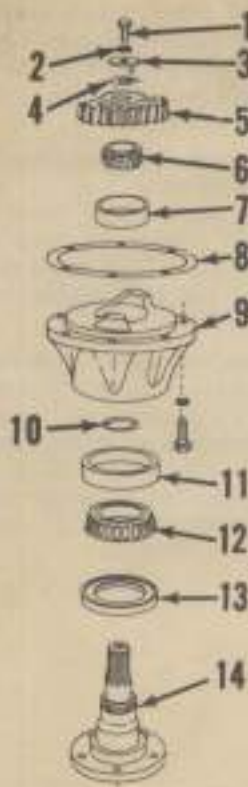


Fig. 8—On single front wheel tricycle models, above parts are used in steering gear instead of items 53 through 62 shown in Fig. 7. Mark on hub of sector gear (5) must be aligned with punch mark on top of sector shaft (14).

- | | |
|-----------------|--------------------|
| 1. Cap screw | 8. Gaskets |
| 2. Lockwasher | 9. Bearing support |
| 3. Flat washer | 10. "O" ring |
| 4. Shim | 11. Bearing cup |
| 5. Sector gear | 12. Bearing cone |
| 6. Bearing cone | 13. Seal |
| 7. Bearing cup | 14. Sector shaft |

tainer, shaft and gear unit. Remove cap screw (1), lockwasher (2), flat washer (3) and vary the number of shims (4) to remove all end play from bearings without causing any binding tendency. Reinstall unit using two new gaskets and tighten retaining cap screws to a torque of 75 Ft.-Lbs. Timing of sector and worm gears is not necessary. Reinstall wheel and fork assembly and tighten fork retaining cap screws to a torque of 130-140 Ft.-Lbs.

On dual wheel tricycle and wide front axle models, steering shaft end play is adjusted by varying the number of shims (60—Fig. 7) between bearing retainer (62) and front support casting (44). Unbolt and remove retainer, shaft and gear assembly and vary the number of shims to remove all bearing end play without causing any binding tendency. Alternate paper and steel shims for proper sealing. Tighten bearing retainer to front sup-

port cap screws to a torque of 70-75 Ft.-Lbs. Reinstall dual wheel pedestal or wide front axle support and tighten retaining cap screws to a torque of 70-75 Ft.-Lbs.

NOTE: Late production models may have an "O" ring seal between the front support (44—Fig. 7) and bearing retainer (62) or (9—Fig. 8).

15. OVERHAUL GEAR UNIT. After removing front support as outlined in paragraph 19, unbolt and remove steering shaft bearing retainer, shaft, bearings and sector gear from bottom of casting. Unbolt and remove wormshaft bearing retainer, wormshaft and bearings from rear of casting. Drive expansion plug (50—Fig. 7) from front of casting; then, drive front bearing cup (43) out to rear. Use a bearing cup puller to remove bearing cup (59) on dual wheel tricycle and wide front axle models.

16. SINGLE FRONT WHEEL SECTOR SHAFT. On single front wheel tricycle models, refer to Fig. 8; then, overhaul removed sector gear, shaft and retainer assembly as follows: Remove cap screw (1), lockwasher, flat washer and shims; then, drive the shaft (14) out of sector gear, bearings and retainer. Further disassembly procedure is evident from reference to Fig. 8 and inspection of parts. Renew any questionable parts. Reassemble using new "O" ring (10) and seal (13) as follows: Drive bearing cups (7 & 11) into retainer (9) making sure that they are firmly seated. Pack lower bearing cone with No. 2 wheel bearing grease and place cone in lower cup. Soak new seal (13) in oil prior to installation, apply sealer to outer rim and install with lip towards bearing.

Install new "O" ring in groove of shaft and insert shaft through seal and bearing cone. Make sure that shoulder on shaft is firmly seated against lower bearing cone. Install upper bearing cone on shaft. Install sector gear on shaft with line mark on hub of gear down and aligned with marked spline on shaft. Install proper number of shims (4) to provide free rolling fit of bearings without end play when cap screw (1) is tightened securely. Install unit in front support using two gaskets (8) and tighten retaining cap screws to a torque of 70-75 Ft.-Lbs.

NOTE: Late production models may have an "O" ring seal between bearing support (9) and front support (44—Fig. 7).

17. DUAL WHEEL TRICYCLE AND WIDE AXLE SECTOR SHAFT. Disassembly of sector shaft unit is evident from exploded view in Fig. 7. To reassemble, drive bearing cups into front support and bearing retainer making sure that they are firmly seated. Soak new seal in oil prior to installation. Apply sealer to outer rim of seal and install seal in retainer with lip towards bearing. Drive lower bearing cone firmly against snap ring (56) on shaft. Install sector gear (see Fig. 9) with line mark on bottom of gear hub aligned with marked spline on shaft. Install upper bearing cone making sure that sector gear is seated against snap ring and that upper cone is tight against sector gear. Insert shaft assembly into front support casting and install bearing retainer (62—Fig. 7) with proper number of shims (60) to provide a free rolling fit of bearings without end play. Alternate paper and steel shims for proper sealing on early models. Late production models are equipped with an "O" ring seal between retainer (62) and front support (44). Tighten retaining cap screws to a torque of 70-75 Ft.-Lbs.

18. WORMSHAFT UNIT—ALL MODELS. Refer to Fig. 7 for disassembly of wormshaft unit. Rear wormshaft bearing is in three pieces: cup (38), roller assembly (39) and cone (40). Drive front bearing cup (43) into front support until cup is firmly seated against shoulder in bore. Apply sealer to rim of expansion plug (50) and drive plug into front support casting only far enough to seal hole. Drive rear bearing cup into retainer (36) until cup is firmly seated. Soak new seal (35) in oil and install



Fig. 9—Align punch mark on steering shaft with line at bottom of steering gear hub as shown.

seal with lip forward in retainer. Drive bearing cones on wormshaft and make sure that they are firmly seated against shoulders on shaft. Insert shaft into front support casting; then, install rear bearing assembly (39) and retainer. Use proper number of shims (37) between retainer and front support casting to provide free rolling fit of bearings without end play. Alternate paper and steel shims to provide proper sealing. Paper and steel shims are each 0.005 thick. No timing of worm gear to sector gear is necessary. Fill front support with SAE 80 EP lubricant to top of sector gear (approximately 3¼-quart capacity).

19. R&R FRONT SUPPORT. Remove the front support from tractor as follows: Remove grille and drain radiator. Remove both hood side panels and unbolt hood center channel from radiator shell. Disconnect tubes from oil cooler on shuttle clutch equipped models. Disconnect both radiator hoses and unbolt radiator shell from side rails and radiator from front support. Remove front support breather and lift radiator and radiator shell from tractor as a unit. Support front end of tractor. Attach a hoist to front support.

On wide front axle models, disconnect tie rods, unbolt front support from side rails and lift front support and front axle support from the front axle pivot pin. Unbolt and remove

front axle support from steering gear unit and remove steering arm from steering shaft. Drain oil from unit while attached to hoist; then move unit to work bench.

On tricycle models, unbolt and remove single wheel fork and wheel or pedestal and wheels from steering gear unit. Drain oil from steering gear. Unbolt front support from side rails and lift front support to work bench.

Reverse removal procedures to re-install front support. Tighten wide front axle support and dual front wheel pedestal retaining cap screws to a torque of 70-75 Ft.-Lbs. Tighten single wheel fork retaining cap screws to a torque of 130-140 Ft.-Lbs.

POWER STEERING SYSTEM

NOTE: The maintenance of absolute cleanliness of all parts is of utmost importance in the operation and servicing of the hydraulic power steering system. Of equal importance is the avoidance of nicks or burrs on any of the working parts.

LUBRICATION AND BLEEDING

20. The front support casting (steering gear housing) is utilized as the power steering fluid reservoir. Fluid level should be maintained at ¼-inch above the top of the sector gear. Capacity is approximately 5 quarts.

Type "A" automatic transmission fluid is recommended for use as power steering fluid in Series II D-15, Series III D-17 and Series IV D-17 tractors. Recommendations for the very earliest production units was SAE 20W oil for all temperatures. On later models, the recommendation was SAE 5W-20 oil for temperatures below 0° F. and SAE 10W-30 oil for temperatures above 0° F. Due to sev-

eral different oils having been recommended, it would be advisable to check with the tractor operator or owner on type of oil being used before adding any oil to the fluid reservoir. Power steering system should be drained and refilled with new oil after each six months of use.

Whenever the power steering oil lines have been disconnected, reconnect the lines, fill the reservoir and cycle the system several times to bleed out any trapped air. Then, check fluid level and refill if necessary.

SYSTEM OPERATING PRESSURE AND RELIEF VALVE

21. A pressure test of the hydraulic circuit will disclose whether the pump, relief valve or some other unit in the system is malfunctioning. To make such a test, proceed as follows: Connect a pressure test gage in series with the pump discharge (pressure) tube (refer to Figs 10, 11, 12, 13 and 12A), run engine at low idle speed until oil is warmed, then turn the steering wheel to either the extreme right or left position. The steering wheel should be held in the extreme position only long enough to observe the gage reading. Pump may be seriously damaged if steering wheel is held in this extreme position for an excessive length of time. Correct engine speed and power steering pressure are as follows:

| | | | |
|-----------------|-------|----------|----------|
| D-14 | ..... | 2000 rpm | 1000 psi |
| D-15 Non-Diesel | ..... | 2200 rpm | 1200 psi |
| D-15 Series II | | | |
| Non-Diesel | .... | 2000 rpm | 1600 psi |
| D-17 | | | |
| Non-Diesel | .... | 2000 rpm | 1000 psi |
| All Diesel | | | |
| Models | ..... | 2000 rpm | 1200 psi |

If gage reading is correct, pump and relief valve are O.K. and any trouble is located in the control valve, power steering cylinder and/or connections.

If the pump output pressure is too high, relief valve is either improperly adjusted or is stuck in the closed position. If the output pressure is too low, the relief valve is improperly ad-

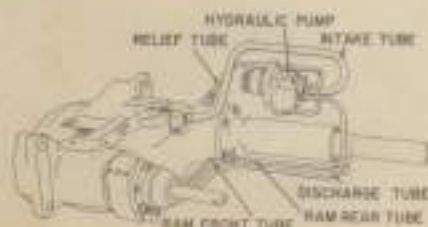


Fig. 10 — Drawing showing the positions of the various power steering tubes, on D-14 and D-15 non-diesel tractors.

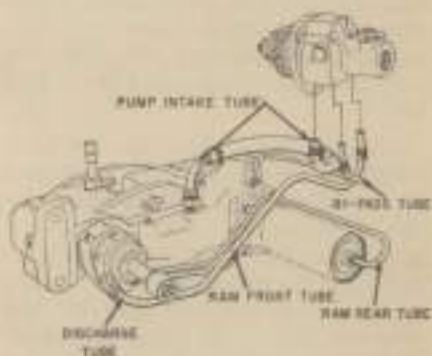


Fig. 11 — Drawing showing the positions of the various power steering tubes used on D-17 non-diesel tractors prior to tractor Serial No. D17-42001.

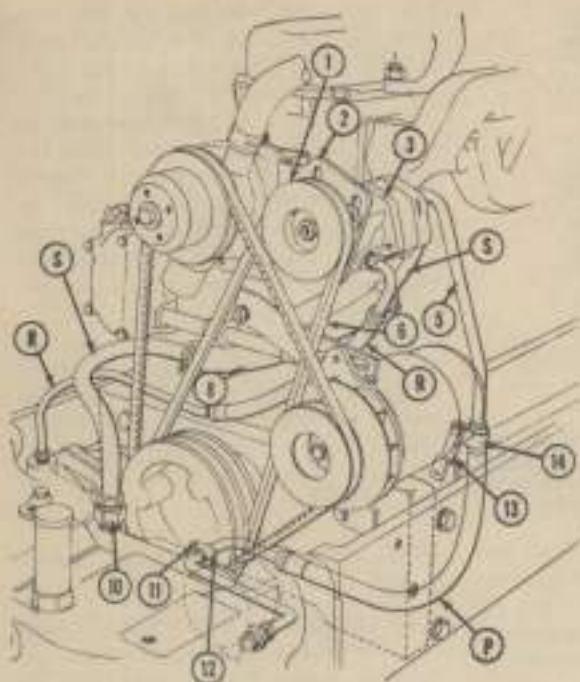


Fig. 12—Drawing showing location of power steering pump and tubes on D-17 non-diesel models, tractor Serial No. D17-42001 and up. Control valve to ram tubes are not shown.

1. Pump drive pulley
2. Pump mounting bracket
3. Pump
4. Pressure tube
5. Return (by-pass) tube
6. Suction tube
7. Snap ring
8. Drive shaft
9. Nut
10. Oil seal
11. Idler gear
12. Woodruff key
13. Idler gear
14. Hex plug

justed, is stuck in open position or the pump requires overhauling. In any event, the first step in eliminating trouble is to adjust the relief valve.

On D-14 and D-15 non-diesel models, the relief valve is adjusted by removing relief valve plug and varying number of shims (9—Fig. 14) as required. If adjustment will not restore pressure, overhaul pump as in paragraph 22A.

On D-17 non-diesel models prior to tractor Serial No. D17-42001, adjustment of the relief valve is accomplished by first removing the power steering pump as outlined in para-

graph 23. Remove the relief valve plug and vary the number of shims (2—Fig. 15) as required to obtain the correct opening pressure.

On D-17 diesel and non-diesel Series III and Series IV models equipped with Webster power steering pump, remove hex plug (10A—Fig. 17) and add or remove shims (12) as necessary to obtain the correct opening pressure.

On D-15 and D-17 diesel models with Barnes power steering pump, the relief valve opening pressure is adjusted by removing the cap nut (12—Fig. 19 or 20) and turning the adjusting screw (14) in or out as necessary to obtain the correct opening pressure.

PUMP

D-14 and D-15 Non-Diesel

22. REMOVE AND REINSTALL. To remove the power steering pump, disconnect all oil tubes; then remove the two nuts attaching the pump to the engine.

Reinstall in the reverse order and after all tubes are connected and the reservoir is filled, bleed the system as outlined in paragraph 20. **NOTE:** On D-14 tractors, "O" ring is used to seal pump to engine instead of gasket (18—Fig. 14).

22A. OVERHAUL. To disassemble pump, remove the screws retaining pump cover (23—Fig. 14) to pump

body (4) and carefully separate cover and body. **CAUTION:** No gasket is used between cover and body. Machined surfaces which are depended upon for sealing cover to body can be damaged if pump is pried apart.

After separating body and cover, remove driven gear (3) and woodruff key, idler gear (22) and shaft assembly. Remove cotter pin, nut (15) and gear (14) from drive shaft (11); then, remove snap ring (13) from pump body and press shaft, snap ring (16) and ball bearing (12) out to front.

Remainder of disassembly is evident from inspection of unit and reference to Fig. 14.

When renewing needle bearings (2), press on lettered end of bearing cage only. On D-15 idler shaft bearings, ends of bearing cages must be 1/16-inch below machined surfaces to provide clearance for snap rings. Other needle bearings should be just below flush with the machined surfaces.

Install drive shaft oil seal (10) with lip to rear. Assemble snap ring (16) and ball bearing (12) on drive shaft and carefully insert shaft through oil seal. **CAUTION:** Press on outer race of ball bearing only to install shaft and bearing assembly in pump body. Then, install snap ring (13) in pump body and install drive gear, nut and cotter pin on drive shaft.



Fig. 13—Drawing showing the positions of the various power steering tubes used on all D-15 diesel tractors and D-17 diesel models prior to tractor Serial No. D17-38964.

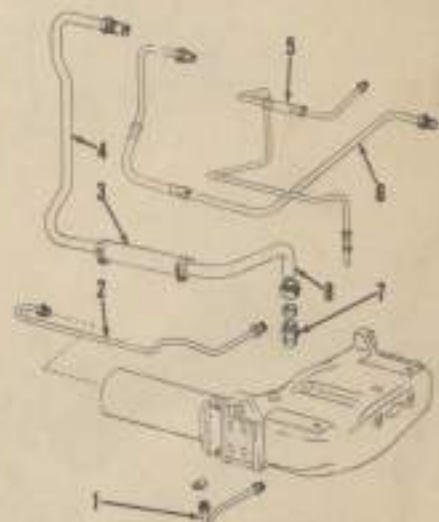


Fig. 13A—Exploded view showing general layout of power steering tubes used on D-17 diesel models of tractor Serial No. D17-38964 and up.

1. Control valve to ram front tube
2. Control valve to ram rear tube
3. Suction tube connector hose
4. Upper suction tube
5. By-pass return tube
6. Pump to control valve pressure tube
7. Suction tube fitting
8. Lower suction tube

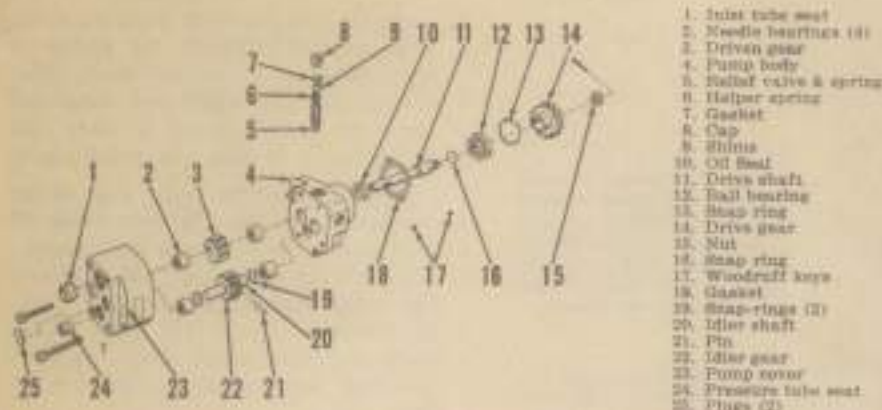


Fig. 14 — Exploded view of D-15 non-diesel power steering pump. D-14 power steering pump is similar except that an "O" ring is used to seal pump to engine instead of gasket (18); snap rings (19) are not used on idler shaft (20) in D-14 pump. Webster power steering pump used on D-15 models after serial number D15-7870 is similar.

Be sure machined surfaces of pump body and cover are clean and free of any nicks and burrs; then, carefully align cover on dowel pins and press cover and body together. Install and tighten screws that retain cover to body.

D-17 Non-Diesel (Prior to Tractor Serial No. D17-42001)

23. REMOVE AND REINSTALL. To remove the power steering pump, first remove the distributor. Disconnect the governor control rod and oil lines from the governor and power

steering pump; then, remove the three stud nuts attaching the pump cover (15—Fig. 15) to the rear face of block flange. Withdraw the governor, power steering pump and distributor drive assembly.

To reinstall, reverse the removal procedure and re-time the distributor as outlined in paragraph 147. Bleed the system as outlined in paragraph 20 after all tubes are connected and reservoir is filled.

23A. OVERHAUL. Disassemble the pump as follows: Remove plug (3—

Fig. 15); then, remove nut (5) and gear (6). Remove the socket head screws (15A) and separate the body (8) from the cover (15). The remainder of disassembly procedure will be evident after an examination of the unit and reference to Fig. 15. Renew any parts which are scored, worn or are in any way questionable. Bearings (10—Fig. 15) should be pressed in bores until end of bearing is just below the machined surfaces.

When reassembling, reverse the disassembly procedure. Mating surfaces of pump body (8) and cover (15) should be coated lightly with plastic lead sealer or equivalent. Reinstall the distributor drive gear (6) with long hub inward.

D-17 Non-Diesel (Tractor Serial No. D17-42001 & Up)

24. REMOVE AND REINSTALL. Disconnect the suction, pressure and by-pass tubes from power steering pump. Remove nut and lockwasher that retain the pump drive pulley, loosen the four cap screws attaching pump to pump mounting bracket and remove pump drive belt and pulley. Unbolt and remove pump from mounting bracket. Reverse removal procedures to reinstall pump; then, refill reservoir and bleed system as outlined in paragraph 20.

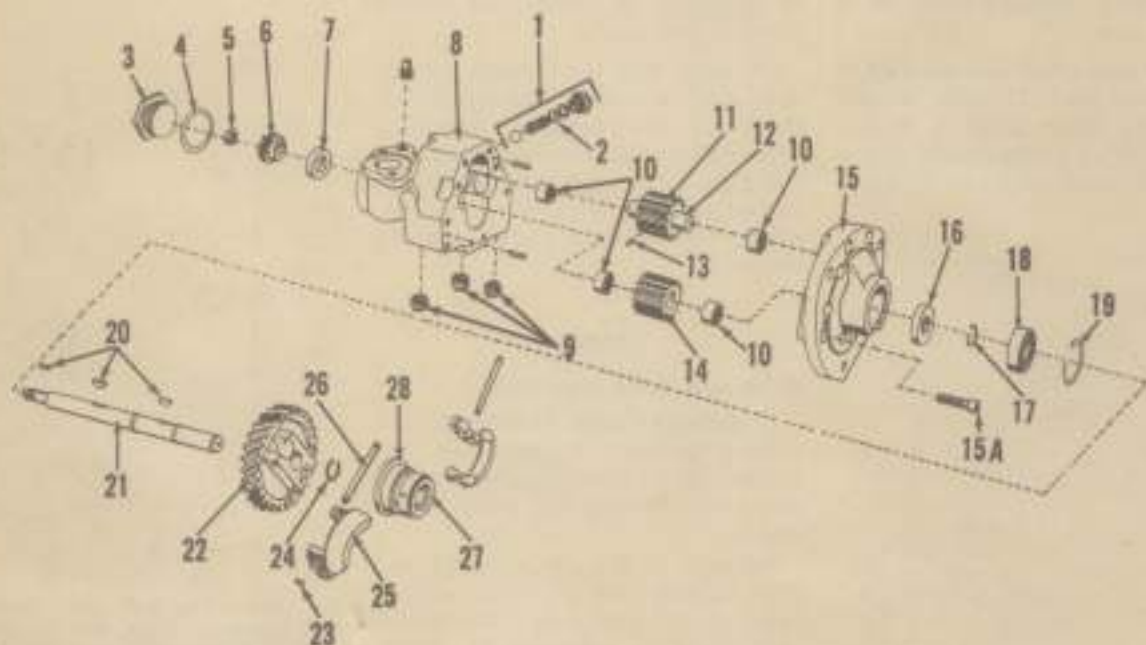


Fig. 15 — Exploded view of the D-17 non-diesel governor, distributor drive and power steering pump assembly used prior to tractor Serial No. D17-42001. Allen head screws (15A) retain the cover (15) to the body (8).

- | | | | | | |
|---------------------------|-----------------------------|---------------------|------------------------|-------------------|----------------------------|
| 1. Ballast valve assembly | 6. Distributor driving gear | 10. Needle bearings | 14. Cover | 18. Snap ring | 24. Snap ring |
| 2. Adjusting shim | 7. Oil seal | 11. Idler gear | 15A. Allen head screws | 19. Woodruff keys | 25. Governor weight |
| 3. Plug | 8. Pump body | 12. Idler shaft | 16. Oil seal | 20. Drive shaft | 26. Thrust pin |
| 4. Gasket | 9. Shim | 13. Shear pin | 17. Snap ring | 21. Governor gear | 27. Thrust bearing |
| 5. Nut | | 14. Pump drive gear | 18. Bearing | 22. Clip | 28. Thrust bearing carrier |

24A. OVERHAUL. After removing the pump as outlined in paragraph 24, scribe a line across cover, gear plate and pump body to aid in re-assembly and proceed as follows: Remove pressure relief valve plug (10A—Fig. 17), "O" ring (11), shims (12), outer spring (13), inner spring (14) and relief valve (15) from pump body. Be careful not to lose or damage any of the shims (12).

After removing the six socket head cap screws (1 and 2—Fig. 16) from cover (rear) end of pump, carefully separate the cover (3), gear plate (4) and body of pump to avoid damage to the mating surfaces. No gaskets are used and the machined surfaces are depended upon for sealing. The hollow dowel pins (5) are a tight fit in the cover, gear plate and pump body.

Inspect all parts for wear, scoring or other damage and renew as necessary. New pump body includes bearings, seal, by-pass tube seat and relief valve assembly. New pump cover includes bearings, expansion plugs, discharge (pressure) tube seat and suction (inlet) tube seat. However, all other pump parts (including those in the body and cover assemblies) are available separately.

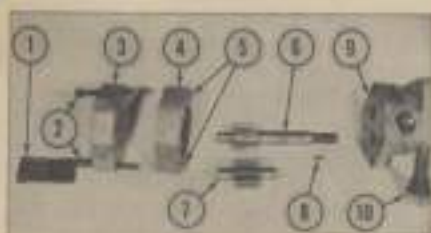


Fig. 16 — Exploded view of Webster power steering pump used on D-17 non-diesel models, tractor Serial No. D17-42001 and up. Pump is also used on diesel models, tractor Serial No. D17-38963 and up, alternately with a Barnes pump.

- | |
|---------------------------|
| 1. 1/2-inch cap screws |
| 2. 1/4-inch cap screws |
| 3. Cover assembly |
| 4. Gear plate |
| 5. Hollow dowels |
| 6. Drive gear and shaft |
| 7. Driven gear and shaft |
| 8. Woodruff key |
| 9. Body assembly |
| 10. Relief valve assembly |

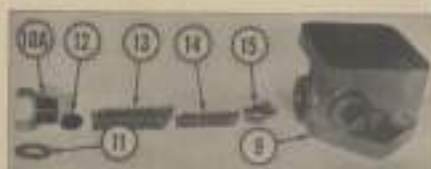


Fig. 17 — Exploded view of Webster power steering pump relief valve assembly shown at 10—Fig. 16.

- | | |
|---------------|------------------|
| 3. Pump body | 13. Outer spring |
| 10A. Hex plug | 14. Inner spring |
| 11. "O" ring | 15. Valve |
| 12. Shims | |

For method of removal and installation of pump shaft bearings, refer to Fig. 18. Bearings (18) in cover may be driven out towards rear after removing the expansion plugs (19). Driven shaft bearing (21) in pump body must be pulled from blind hole. The drive shaft bearings (16 and 16A) can be driven out front end of body after removing seal (22). New bearings should be pressed into place. Press on lettered end of cage only as opposite end of cage is soft and is easily distorted. Press bearings into cover 0.020 below flush with surface towards gear plate. Press driven shaft bearing 0.020 below flush with sur-

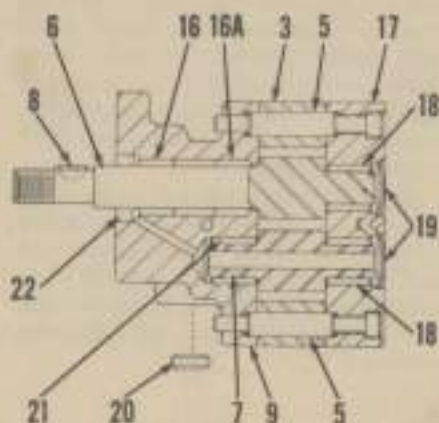


Fig. 18 — Cross-sectional view of Webster power steering pump showing bearing and seal location. Refer to Fig. 16 and Fig. 17 for exploded views.

- | | |
|--------------------------|---------------------|
| 2. Gear plate | 16A. Needle bearing |
| 5. Hollow dowels | 17. Pump cover |
| 6. Drive gear and shaft | 18. Needle bearings |
| 7. Driven gear and shaft | 19. Expansion plugs |
| 9. Pump body | 20. Tube seat |
| 14. Needle bearing | 21. Needle bearing |
| | 22. Shaft seal |

face of pump body. Press rear drive shaft bearing (16A) into body against shoulder in bore and front drive shaft bearing (16) in flush with counter-bore. NOTE: Do not force rear bearing cage in against shoulder. Press new double lip seal (22) in flush with mounting surface of pump body with heaviest sealing lip inward.

To install drive shaft and gear, use a seal protector on end of shaft or use suitable smooth pointed tool to work inner lip of seal over shoulder on drive shaft. Install idler gear, gear plate and cover making sure that previously scribed mark across cover, gear plate and body is realigned. The 1/4-inch hole in gear plate must align with the 1/4-inch hole in rear cover. Install the two 1/4-inch socket head cap screws through holes with hollow dowel pins. Tighten the 1/4-inch screws to a torque of 85-105 inch-pounds and the 1/2-inch screws to a torque of 190-210 inch-pounds.

D-15 Diesel and D-17 Diesel (Prior to Tractor Serial No. D17-38964)

25. REMOVE AND REINSTALL. The power steering pump is mounted on the rear cover of the generator and is driven by a coupling splined to the generator armature shaft. Removal procedure is self-evident.

25A. OVERHAUL. Refer to Fig. 19. To disassemble pump, remove screws retaining pump housing (2) to pump body (7) and carefully separate housing and body. Note: Machined surfaces of housing and body are depended upon for sealing and can be damaged if pump is pried apart.

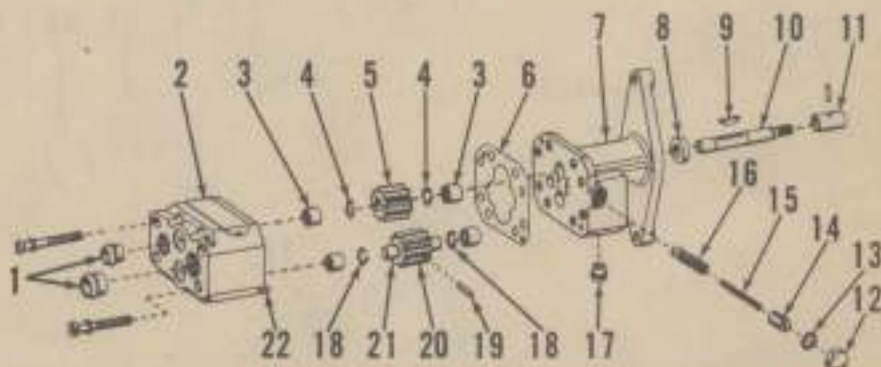


Fig. 19 — Exploded view of Barnes power steering pump used on all D-15 diesel models and D-17 diesel models prior to tractor Serial No. D17-38964. Gasket (16) was not used in early production units; however, it may be used in servicing the earlier pumps. The Barnes pump used alternately with the Webster pump (Figs. 16, 17 & 18) after tractor Serial No. D17-28963 is similar to above pump except for drive end. Refer to Fig. 20.

- | | | | |
|------------------------|--------------------|----------------------------|--------------------|
| 1. Tapping seats | 7. Pump body | 15. Gasket | 18. Snap rings (2) |
| 2. Pump housing | 8. Seal | 14. Adjusting screw | 19. Pin |
| 3. Needle bearings (4) | 9. Woodruff key | 15. Inner spring | 20. Idler gear |
| 4. Snap rings (2) | 10. Drive shaft | 16. Ball & spring assembly | 21. Idler shaft |
| 5. Drive gear | 11. Drive coupling | 17. Tapping seat | 22. Dowel pins (2) |
| 6. Gasket | 12. Acorn nut | | |

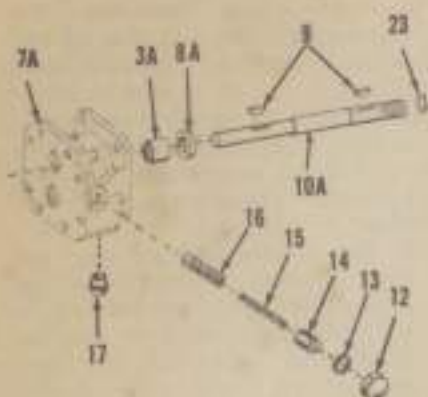


Fig. 20—After diesel tractor Serial No. D17-38963, a Barnes pump similar to that shown in Fig. 19, except for drive end parts shown above, is used alternately with a Webster pump.

- 3A. Needle bearing
- 7A. Pump beam
- 8A. Shaft seal
- 8. Woodruff keys
- 10A. Drive shaft
- 12. Adjust nut
- 13. Gasket
- 14. Adjusting screw
- 15. Inner spring
- 16. Ball and spring assembly
- 17. Tubing seal
- 23. Snap ring

Idler gear on early production pumps is secured to shaft with pin driven into blind hole in gear and shaft. On later production pumps, pin (19) in shaft (21) engages keyway in idler gear (20) and gear can be removed from shaft after removing snap rings (4). Drive gear (5) can be removed from drive shaft after removing snap rings (4).

Gasket (6) was not used on early production pumps, although the 0.0005 thick plastic gasket can be used in reassembly of these earlier units. Install seal (8) with lip to rear.

When renewing needle bearings (3), press on lettered end of bearing cage only. Opposite end of bearing cage is soft and is easily distorted. If no snap rings are used on idler shaft, press idler shaft bearings to just below flush with machined surfaces. If equipped with snap rings, press bearing cages to $\frac{1}{2}$ -inch below flush with machined surfaces.

Be sure that machined surfaces of housing and cover are clean and free of nicks or burrs. Place gasket (6) over dowel pins; then, carefully align housing on dowel pins, press housing and body together and install housing retaining screws.

D-17 Diesel (After Tractor Serial No. D17-38963)

26. REMOVE AND REINSTALL. Loosen the nut retaining the pulley to the pump drive shaft. Disconnect the pressure, by-pass and suction tubes from the pump. Loosen the cap screws retaining pump to pump mounting bracket and remove drive pulley and belt. Remove pump from mounting bracket.

26A. OVERHAUL. If equipped with a Barnes power steering pump, refer to Fig. 20 and to paragraph 25A. Follow same general overhaul procedures as outlined for the prior production Barnes pump that was mounted on rear of generator.

If equipped with the optional Webster power steering pump, refer to overhaul procedures as outlined in paragraph 24A for non-diesel power steering pump.

STEERING CONTROL VALVE

27. REMOVE AND REINSTALL. To remove the steering control valve and wormshaft unit (Fig. 21), first remove the front support as outlined in paragraph 22. With the front support removed, disconnect the power steering tubes from the control valve; then, unbolt and withdraw the control valve and wormshaft unit.

Reinstall by reversing the removal procedure. Install new gasket (37—Fig. 23) and tighten retaining cap screws to a torque of 24 Ft.-Lbs. After installation is complete and reservoir is filled, bleed the system as outlined in paragraph 20.

27A. OVERHAUL. After removing the unit as outlined in paragraph 27, scribe a line across rear cover (2—Fig. 21), body (10) and front cover (19) to aid in reassembly of the unit. Then, proceed as follows:

Unbolt and remove the rear cover (2), unstack and remove the bearing adjusting nut (3) and lift out the thrust bearing (5). Withdraw the body and spool assembly (10 and 12) and thrust bearing (5A). Be careful when removing the body and do not drop or nick any of the component parts. Carefully slide the spool (12) from the valve body and remove the active plungers (15) and centering spring(s) (16).

NOTE: There are five drilled holes through the control valve housing surrounding the valve spool bore. On some early production units, active (centering) plungers and springs were used in three holes; the

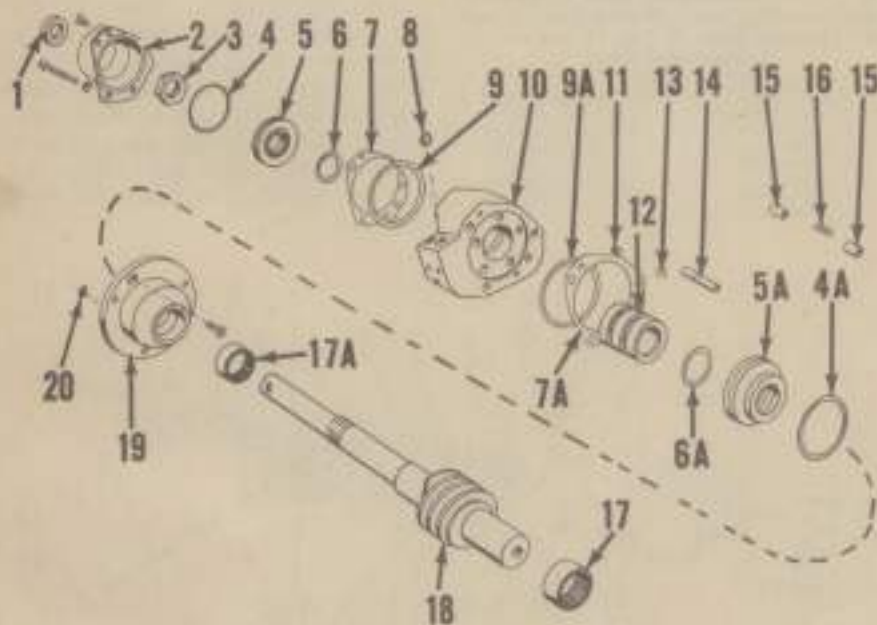


Fig. 21—Exploded view of power steering control valve unit. Later production unit is shown; early production valves may be overhauled as described in text using lower parts shown above.

- | | | | |
|-------------------|--------------------|-------------------------|---------------------|
| 1. Seal | 5A. Thrust bearing | 8A. "O" ring | 16. Spring |
| 2. Rear cover | 6. Gasket | 9. "O" ring | 17. Needle bearing |
| 3. Adjusting nut | 7. Blind | 9A. "O" ring | 17A. Needle bearing |
| 4. "O" ring | 7A. Blind | 10. Control valve body | 18. Wormshaft |
| 5. Thrust bearing | 8. Tube seal | 11. Check valve | 19. Front cover |
| | 8A. "O" ring | 12. Control valve spool | 20. "O" ring |
| | | 13. Plug | |
| | | 14. Inactive plunger | |
| | | 15. Active plungers | |

remaining two holes being filled with inactive plungers (steel rods). Later control valves incorporated a 0.031 I.D. restrictor in one of the holes, active plungers with centering springs were used in two holes and two holes were filled with inactive plungers. These later valves were then modified by removing the active plungers and centering spring from one hole and filling the hole with another inactive plunger. Steel shims (7 and 7A—Fig. 21) were also added to the control valve assembly at that time. When servicing a control valve containing two sets of active plungers (four plungers and two centering springs), one set of the active plungers should be discarded and a new inactive plunger installed in that bore. Shims (7 and 7A) should also be installed. Refer to the following service procedure.

The inactive plungers (14—Fig. 21) need not be removed if they are tight in their bores and ends of plungers are flush with ends of valve housing. The inactive plungers are steel rods serving no purpose other than filling the drilled holes in the valve housing in which centering plungers or the restrictor bushing are not used. If for some reason, the inactive plungers have been removed, they should be reinstalled with the stake mark on plunger to outside of valve body to prevent distortion of the valve spool bore. Note: Later production valve bodies may not have the extra drilled holes.

Carefully clean the control valve parts in fuel oil or other solvent and be sure the restrictor passageway is open and clean as well as other oil passages in the valve body. The restrictor may be checked and cleaned with a No. 68 wire size drill. Be careful not to enlarge the restrictor I.D. above the 0.031 dimension.

As the control valve body and valve spool are a matched assembly, they are not available separately for service. However, the following parts in control valve body are renewable: Active plungers and centering spring (15 and 16), inactive plungers (14), core hole steel sealing balls (13), check valve assembly (11) and tubing seals (B).

Renew all "O" rings, seal (1) and adjusting nut (2) when reassembling. Renew needle bearing (17A) in front cover or needle bearing in front support casting if loose or damaged. Renew all other questionably worn or scored parts.

To reassemble, place front cover and bearing on wormshaft. To facilitate further assembly, clamp wormshaft in a vertical position (rear end up) in a vise. Be careful not to damage gear or bearing surfaces. Place thrust bearing on shaft with small side towards front cover. Press bearing down on shaft into front cover until flush with cover. Place one shim on cover. Lubricate valve spool and place spool in housing with identifying groove in spool I.D. to front side of valve body. Insert centering spring with plunger at each end of spring in active plunger bore. If the inactive plungers have been removed, be sure that active plungers and centering spring are installed in bore nearest restrictor passage and install inactive plungers in remaining bores with punch mark on plungers to outside of valve body. Place large "O" ring in groove on front side of valve body and small "O" ring in groove in thrust bearing. Lower the valve body and spool assembly over shaft using attaching cap screws as guide pins to align body, shim and front cover. Install the flat head screws that retain front cover to valve body. Place small "O" ring in rear thrust bearing groove and install thrust bearing over shaft with "O" ring next to valve spool. Install adjusting nut and torque nut to 60 inch-pounds; then, back off nut 1/4-turn (two flats). Using a center punch, stake nut to shaft at keyway. Place shim and large "O" ring on valve body and install rear cover with new seal. Secure cover to valve body with two flat head screws.

STEERING CYLINDER (RAM)

28. R&R AND OVERHAUL. To remove the power steering ram, first remove the front support as outlined in paragraph 32, then proceed as follows: Remove the rack adjusting block (48—Fig. 23) and make certain that shims (49) are not lost or damaged. Disconnect oil lines from the ram, remove the retaining cap screws and, while holding the rack away from the idler gear (64), withdraw the ram assembly from the front support casting.

To overhaul the removed unit, refer to Fig. 22 or 22A and proceed as follows: Remove the pin attaching rack (68) to the piston rod (73A); then, extract snap ring (69) retaining the rear cap (70) in cylinder (67) and withdraw the rod and piston unit.

Examine all parts and renew any that are scored or show excessive wear. Lubricate all parts prior to assembly, renew all "O" rings and reassemble by reversing disassembly procedure. Note: Prior to attaching the rack (68—Fig. 23) to the piston rod, insert the rack into the steering gear housing in mesh with the idler gear, reinstall rack adjusting block and shims, and check backlash between rack and idler gear. The rack should move freely without backlash. If it does not, vary the number of shims between the rack adjusting block (48) and the front support casting to provide this condition. Paper

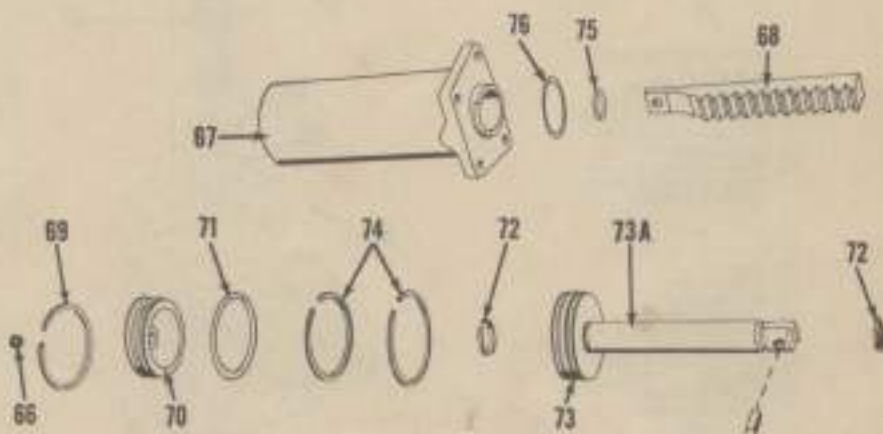


Fig. 22 — Exploded view of the power steering ram (cylinder) typical of all models except D-14 and D-15 non-diesel.

| | | | |
|------------------|---------------|-----------------|--------------------------|
| 66. Port seal | 69. Snap ring | 72. Soap rings | 74. Piston ring |
| 67. Ram cylinder | 70. Rear cap | 73. Ram piston | 75. Piston rod "O" ring |
| 68. Ram rack | 71. "O" ring | 73A. Piston rod | 76. Ram support "O" ring |

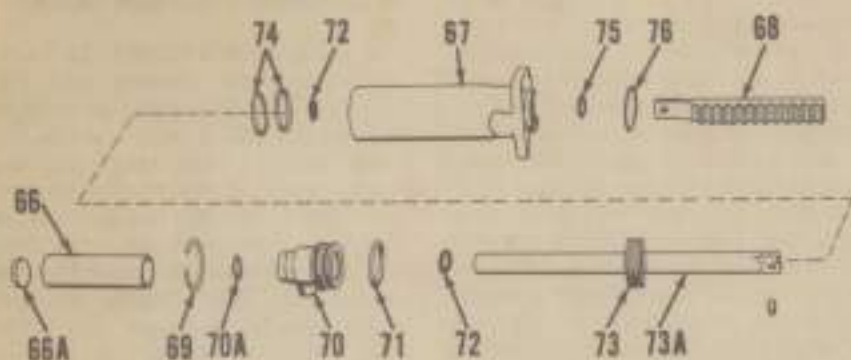


Fig. 22A—Exploded view of the power steering ram (cylinder) typical of type used on D-14 and D-15 non-diesel models.

- | | | | |
|------------------|----------------|-----------------|----------------|
| 66. Ram shield | 70. Rear cup | 73. Ram piston | 76. Piston rod |
| 67. Ram cylinder | 70A. "O" ring | 73A. Piston rod | 76A. "O" ring |
| 68. Ram rack | 71. "O" ring | 74. Compression | |
| 69. Seal ring | 72. Seal rings | ring | |

shims (0.005 thick) and steel shims (0.003 thick) should be alternately placed for proper sealing. When proper adjustment is obtained, remove the rack adjusting block, taking care not to lose or damage shims and remove rack from housing. Attach rack to piston rod with pin and rivet pin securely taking care not to draw ears of piston rod together.

29. To reinstall the ram, reverse the removal procedure and position the rack as follows: Rotate the steering shaft (57) to the full right (counter-clockwise as viewed from lower end of steering shaft), then pull the ram rack to the fully extended position. Engage the rack and idler gear teeth; then, install the rack adjusting block (48) with proper number of shims (49) as selected during previous step. Alternate paper and steel shims for proper sealing.

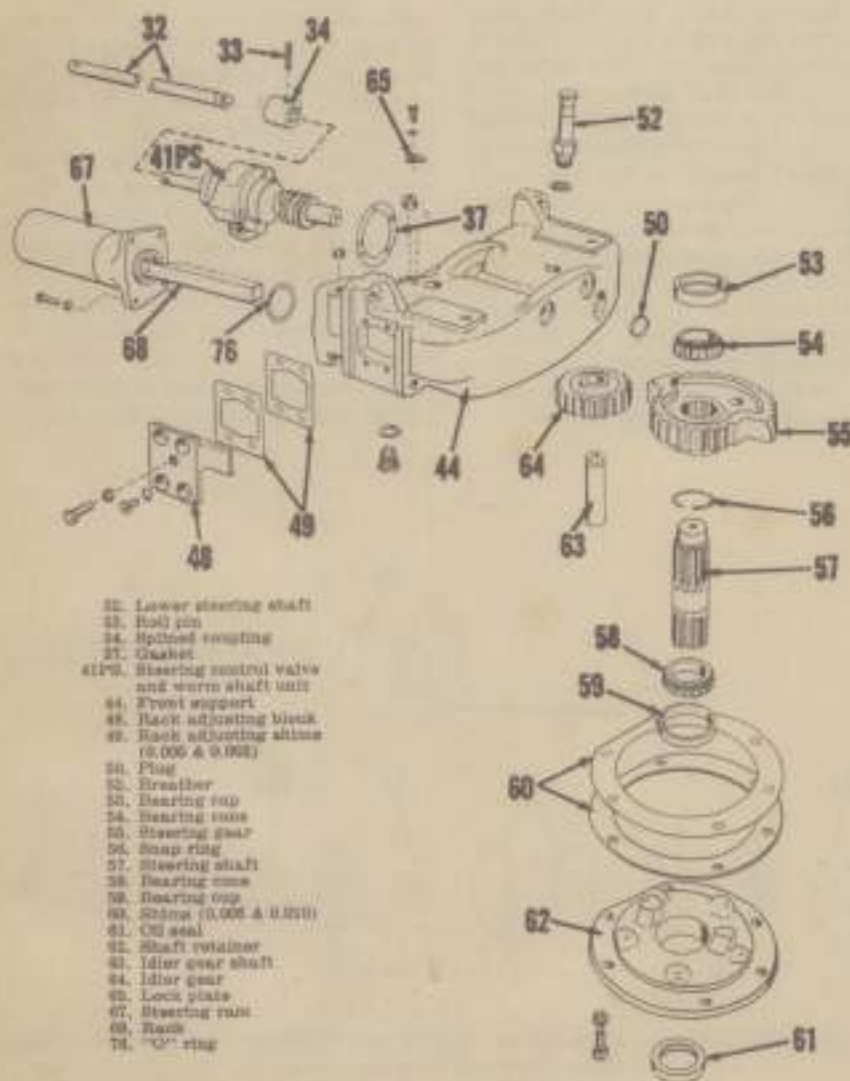
GEAR UNIT

The worm and sector type gear unit is contained in the front support casting (44—Fig. 23). Lubricating oil for the gear unit is also used as power steering fluid. Oil level should be maintained at 3/8-inch above the sector (steering) gear. Refer to paragraph 30 for filling and bleeding procedures and for recommended power steering fluid.

30. ADJUSTMENTS The gear unit is provided with two adjustments: Rack mesh position is adjusted by varying the number of shims between the front support casting and the rack adjusting block (48—Fig. 23). Steering shaft bearing end play is also adjustable by varying the number of shims (4—Fig. 24) between the sector gear (5) and flat washer (3) on single front wheel models and by varying the number of shims (60—Fig. 23) between the bearing retainer (62) and front support casting (44) on dual wheel tricycle and all wide front axle models. However, these adjustments are more in the nature of assembly procedure when overhauling the front support (steering gear) assembly than routine adjustment. Therefore, these adjustments will be discussed under reassembly of gear unit. Refer to paragraph 31.

31. OVERHAUL FRONT SUPPORT. With unit removed as outlined in paragraph 32, proceed as follows:

Remove power steering tubes from ram cylinder and control valve. Un-



- | | |
|--|---------------------------|
| 32. Lower steering shaft | 65. Plug |
| 33. Ball pin | 66. Breather |
| 34. Hydraulic coupling | 67. Bearing cap |
| 37. Gasket | 68. Bearing cone |
| 41PS. Steering control valve and worm shaft unit | 69. Steering gear |
| 44. Front support | 70. Soap ring |
| 48. Rack adjusting block | 71. Steering shaft |
| 49. Rack adjusting shims (0.005 & 0.003) | 72. Bearing cone |
| 50. Plug | 73. Bearing cap |
| 52. Breather | 74. Shims (0.005 & 0.003) |
| 53. Bearing cap | 75. Oil seal |
| 54. Bearing cone | 76. Shaft retainer |
| 55. Steering gear | 77. Idler gear shaft |
| 56. Soap ring | 78. Idler gear |
| 57. Steering shaft | 79. Lock plate |
| 58. Bearing cone | 80. Steering ram |
| 59. Bearing cap | 81. Rack |
| 60. Shims (0.005 & 0.003) | 82. "O" ring |
| 61. Oil seal | |
| 62. Shaft retainer | |
| 63. Idler gear shaft | |
| 64. Idler gear | |
| 65. Lock plate | |
| 66. Steering ram | |
| 67. Rack | |
| 68. "O" ring | |

Fig. 23—Partially exploded view of the power steering front support. For exploded views of the control valve unit (41PS) and ram (67) refer to Figs. 21, 22 and 22A.



Fig. 24—On single front wheel tricycle models, above parts are used in steering gear instead of items 53 through 62 shown in Fig. 23. Mark on hub of sector gear (5) must be aligned with punch mark on top of sector shaft (14).

- | | |
|-----------------|--------------------|
| 1. Cap screw | 8. Gaskets |
| 2. Lockwasher | 9. Bearing support |
| 3. Washer | 10. "O" ring |
| 4. Shim | 11. Bearing cup |
| 5. Sector gear | 12. Bearing cone |
| 6. Bearing cone | 13. Seal |
| 7. Bearing cup | 14. Sector shaft |

bolt, remove and overhaul the ram cylinder as outlined in paragraph 28. Unbolt, remove and overhaul control valve and wormshaft unit as outlined in paragraphs 27 and 27A.

Unbolt bearing retainer (9—Fig. 24 on single front wheel models or 62—Fig. 23 on other models) and remove bearing retainer, steering shaft and sector gear assembly from bottom of front support casting. Be careful not to lose or damage shims (60—Fig. 23) on dual wheel tricycle or wide front axle models. Note: Late production models will have an "O" ring seal between bearing retainer and front support casting.

Remove idler shaft lock (65) then pull idler shaft from top of front support casting. (Top end of idler shaft has threaded hole to facilitate removal). Withdraw idler gear through bottom opening in casting.

Thoroughly clean the front support casting because it functions as the power steering fluid reservoir and cleanliness is of utmost importance. Following procedures should be observed in overhaul and reassembly of unit.

SINGLE FRONT WHEEL STEERING SHAFT ASSEMBLY. Refer to Fig. 24. Remove cap screw (1), lockwasher (2), flat washer (3) and shims (4). Be careful not to lose or damage shims. Drive or press the shaft (14) out of sector gear, bearings and retainer. Further disassembly is evident from reference to Fig. 24 and inspection of unit.

Check teeth of sector gear and splines in gear hub and on steering shaft for wear. Any excessive play between steering unit gears or looseness of sector gear on shaft may cause shimmy of front wheels. Renew any questionable parts. Inspect bearings for damage or wear and renew if necessary.

To reassemble, install new "O" ring (10) in groove on steering shaft. Drive both bearing cups into retainer until they are firmly seated. Pack lower bearing cone with No. 2 wheel bearing grease and place cone in cup. Soak new seal in oil, apply sealer to outer rim of seal and install in bearing retainer with lip towards bearing. Insert steering shaft through seal and the lower bearing cone and make sure that shoulder on shaft is seated against bearing cone. Install the upper bearing cone on shaft. Install sector gear on shaft with line mark on bottom of gear hub aligned with marked spline on shaft. Install cap screw, lockwasher and flat washer with proper amount of shims (4) to provide a slight pre-load on bearings when capscrew is tight.

DUAL FRONT WHEEL OR WIDE FRONT AXLE STEERING SHAFT ASSEMBLY. Refer to Fig. 23 for disassembled view of steering (sector) shaft unit (items 53 through 62). Check teeth of sector gear and splines in gear hub and on shaft for wear. Any excessive play (backlash) between steering unit gears or looseness of sector gear on shaft may cause shimmy of front wheels. Renew any questionable parts. Inspect bearings for damage or wear and renew if necessary.

Drive lower bearing cup into bearing retainer (62) and upper bearing cup into front support casting (44) until cups are firmly seated. Soak new seal (61) in oil, apply sealer to outer rim of seal and install seal in bearing retainer with lip of seal towards bearing.

Install snap ring (56) in groove on steering shaft. Drive lower bearing cone tightly against snap ring. Refer to Fig. 9 and install sector gear on shaft in proper alignment. Be sure that hub of gear is tight against upper side of snap ring (56—Fig. 23) and install upper bearing cone tightly against sector gear.

IDLER GEAR AND SHAFT. Check idler gear (64—Fig. 23), for any wear or damage of gear teeth or looseness on shaft (63) and renew gear and/or shaft as necessary. Place gear in front support casting through bottom opening and drive the shaft into place from top. Install lock (65).

ASSEMBLY AND ADJUSTMENT. Install the previously assembled single front wheel steering shaft unit using two new gaskets (8—Fig. 24); or, on other models, install steering shaft assembly (items 53 through 62—Fig. 23) using proper number of shims (60) to give a slight pre-load to bearings. Note: Late production models also have an "O" ring seal between the bearing retainer and front support casting. Use paper shims (0.005 thick) and steel shims (0.010 thick) alternately for proper sealing on models not equipped with "O" ring. Tighten retaining cap screws to a torque of 75 Ft.-Lbs. Check backlash between idler gear and sector gear. If backlash is excessive, renew parts as necessary to correct this condition. Note: it may be possible to eliminate a small amount of backlash by re-positioning the idler gear. If this procedure is followed, be sure to mark mesh position of gears so that they may be re-installed in this same relative position. Backlash should be checked with the sector shaft in mid (straight ahead) position. After being sure that no noticeable backlash is present, remove the sector gear and shaft assembly so that the rack mesh adjustment may be made as outlined in paragraph 28. After the rack mesh position is adjusted, reinstall sector shaft and gear assembly; then, complete the assembly of cylinder unit and install the cylinder as outlined

in paragraph 28. Tighten sector shaft bearing retainer cap screws to a torque of 90-100 Ft.-Lbs. and check to see that sector (steering) shaft can be turned an equal distance each way from centered position.

Install the power steering control valve and wormshaft unit using a new gasket (37) and tighten cap screws to a torque of 24 Ft.-Lbs. No timing of wormshaft gear to sector gear is necessary. Note: The wormshaft is mounted on straight needle bearings to allow end play in the shaft which is necessary to actuate the power steering control valve spool.

Reinstall the power steering tubes to ram cylinder and control valve; then, reinstall the front support as outlined in paragraph 32 and refill and bleed the system as outlined in paragraph 29.

FRONT SUPPORT

32 REMOVE AND REINSTALL. Remove grille and drain radiator. Remove both hood side panels and unbolt hood center channel from radiator shell. Unbolt radiator shell from side rails and radiator from front support. Disconnect tubes from oil cooler on shuttle clutch equipped models. Disconnect both radiator hoses. Remove front support breather and remove radiator and radiator shell as a unit. Support front end of tractor. Unbolt and remove single front wheel fork and wheel assembly, dual wheel tricycle pedestal and wheel assembly or wide front axle support casting. On wide front axle models, drive pin from center steering arm and remove steering arm from shaft. Drain power steering fluid from front support on all models.

Disconnect tubes from power steering pump. Attach hoist to front support; then, unbolt and remove front support from side rails.

Reverse removal procedures to reinstall front support. Refill front support with proper fluid and bleed any trapped air from system as outlined in paragraph 29.



Fig. 29 — Tighten D-14 and D-15 non-diesel cylinder head cap screws in sequence shown.

ENGINE AND COMPONENTS

R&R ENGINE WITH CLUTCH

Non-Diesel

33. To remove the engine and clutch as a unit, first drain the cooling system and, if engine is to be disassembled, drain the oil pan. Perform a front split as outlined in paragraph 13 and proceed as follows: Disconnect the ground strap from battery; then, disconnect wiring from generator and ignition coil. Remove the hood center channel, muffler and the right side sheet from below fuel tank. Remove the air cleaner tube and front governor control rod. Disconnect oil pressure gage line, fuel line, choke rod and temperature gage bulb from engine. Disconnect the lower steering shaft from universal joint; then, unbolt and remove both engine side rails. Support engine in hoist, remove the cap screws retaining engine adapter plate to torque housing, separate the engine from torque housing and move the engine to a stand or work bench.

Reinstall engine and clutch unit by reversing removal procedures.

Diesel

34. To remove the diesel engine and clutch as a unit, first drain the cooling system and, if engine is to be disassembled, drain the oil pan. Perform a front split as outlined in paragraph 13 and proceed as follows:

On D-17 models after tractor Serial No. D17-42000, disconnect ground strap from batteries; then, disconnect wiring from intake manifold heater, generator and voltage regulator. Disconnect tubes from air cleaner and unbolt and remove hood center channel with air cleaner and voltage regulator attached.

On D-17 models prior to tractor Serial No. D17-42001 and all D-15 models, remove the air cleaner and

air cleaner tube from engine. Unbolt and remove the hood center channel.

On all models, proceed as follows: Remove the main fuel line running to the primary filter and the fuel leak-off line from fuel tank to engine. Remove the muffler, left side sheet from below fuel tank and the throttle and fuel shut-off rods. Disconnect the oil pressure gage line and the temperature bulb from engine. Disconnect the lower steering shaft from universal joint; then, unbolt and remove both engine side rails. Support engine in hoist, remove the cap screws retaining engine adapter plate to torque housing, separate engine from torque housing and move the engine to a stand or bench.

Reinstall engine and clutch unit in reverse of removal procedure. Bleed the fuel system as outlined in paragraph 113.

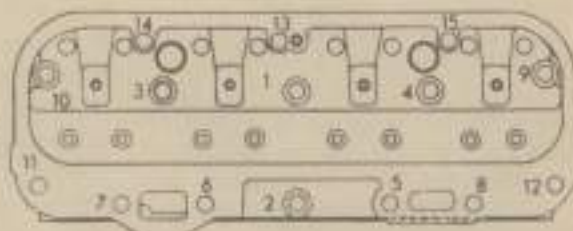
CYLINDER HEAD

D-14 and D-15 Non-Diesel

35 REMOVE AND REINSTALL. To remove the cylinder head, remove both hoods and center channel. Drain coolant, then remove upper radiator hose and thermostat housing. Remove carburetor hose and link spring; then, disconnect carburetor link, fuel line and choke rod from carburetor. Unbolt and remove manifolds, carburetor and muffler as a unit. Remove rocker arm cover, rocker arm assembly and push rods. Disconnect spark plug wires, oil line to head and temperature gage bulb. Remove head retaining cap screws, then remove head.

When reinstalling, reverse the removal procedure and tighten the head retaining cap screws in order shown in Fig. 29. Retighten after engine has reached operating temperature to a torque of 80-85 Ft.-Lbs.

Fig. 30 — Tighten D-17 non-diesel cylinder head cap screws and stud nuts in sequence shown. Refer to text for torque specifications.



D-17 Non-Diesel**36. REMOVE AND REINSTALL.**

To remove the cylinder head, first drain the cooling system, then proceed as follows: Remove both hood side panels and the center channel. Remove the air cleaner tube and disconnect the carburetor link, fuel line and choke rod from carburetor. Unbolt and remove manifolds, carburetor and muffler as a unit. Disconnect the temperature gage bulb and remove the four nuts from cylinder head studs that extend through the water manifold (thermostat housing) and core hole cover. Disconnect upper hose from radiator and by-pass hose from water pump; then, remove the thermostat housing and hoses as a unit. Disconnect spark plug wires and oil line to cylinder head. Remove the rocker arm cover, rocker arm assembly and push rods. Remove cylinder head retaining cap screws and lift head from engine.

When reinstalling cylinder head, reverse removal procedures and tighten the head retaining cap screws and stud nuts in order shown in Fig. 30. Tighten the $\frac{1}{2}$ -inch cap screws and the four stud nuts to a torque of 90-95 Ft.-Lbs. and the $\frac{1}{4}$ -inch cap screws to a torque of 70-75 Ft.-Lbs. Recheck torque after engine has reached operating temperature.

D-15 and D-17 Diesel**37. REMOVE AND REINSTALL.**

To remove the cylinder head, proceed as follows: Remove both hood side panels and the center channel. Drain the cooling system, disconnect water pump drain tube and unbolt water pump from head. Remove the oil line that runs from the oil gallery to cylinder head and disconnect the heat indicator bulb from water outlet casting (manifold) on top of head. Disconnect by-pass hose from thermostat housing and remove the cap screw retaining the water inlet pipe to cylinder head. Remove the thermostat housing from water manifold and water manifold from cylinder head. Remove the intake manifold heater cable and remove the manifold air inlet tube. Remove the fuel return lines from between injector pump and injector leak-off line and from between fuel tank and the rear injector. Disconnect high pressure lines from injector nozzles. Remove rocker arm cover, rocker arm assembly and push rods. Remove the cylinder head retaining stud nuts or cap screws and

washers and lift cylinder head from engine. Note: Some mechanics may prefer to remove the intake and exhaust manifolds from cylinder head before removing head from engine.

Latest type cylinder head gasket has individual "fire rings" for each cylinder. After cleaning head and block surfaces, place gasket on block with imprint "THIS SIDE DOWN" against block. Hold gasket in place with guide studs and place a fire ring in each cylinder opening of gasket with rounded side of ring up. Set cylinder head down over guide studs taking care not to disturb placement of cylinder head gasket and fire rings.

When reinstalling the cylinder head, tighten the stud nuts or cap screws progressively from the center of head outward. Tighten the stud nuts on D-17 diesel engines prior to engine Serial No. 105101 to a torque of 95 Ft.-Lbs. Later D-17 diesel engines and all D-15 diesel engines use screws and washers instead of stud bolts and nuts. Tighten the cap screws to a torque of 105 Ft.-Lbs. on late D-17; 110-120 Ft.-Lbs. on D-15 diesel engines.

Complete reassembly by reversing removal procedure. Operate engine until normal operating temperature is reached, recheck cylinder head cap screw torque and readjust valve tappet gap (hot) to 0.010 on intake valves and 0.019 on exhaust valves.

VALVES, SEATS AND ROTATORS**Non-Diesel**

38 Inlet valves for D-14 and D-15 non-diesel engines have a face and seat angle of 45 degrees. Seat width can be narrowed using 30 and 60 degree stones to obtain the desired seat width of $\frac{1}{16}$ to $\frac{3}{32}$ inch. Valve stem diameter is 0.3407-0.3417 for D-14 and D-15 models.

Inlet valves for D-17 non-diesel engines have a face and seat angle of 30 degrees. The seat width can be narrowed by using 15 and 70 degree stones to obtain the desired seat width of $\frac{1}{16}$ to $\frac{3}{32}$ -inch. Valve stem diameter is 0.371-0.372.

The exhaust valves for all non-diesel engines have a face and seat angle of 45 degrees. The seat width can be narrowed by using 30 and 60 degree stones to obtain the desired seat width of $\frac{1}{16}$ to $\frac{3}{32}$ -inch. The exhaust valves seat in renewable ring type inserts which are available for serv-



Photos Courtesy of Perfect Circle Corp.

Fig. 31 — Views A through E illustrate method of installing valve stem seals on late production diesel models.

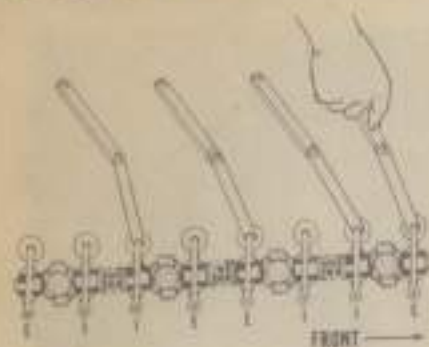


Fig. 32—All non-diesel models. With number 1 piston at TDC on compression stroke, valve clearances (tappet gap) can be set on the four valves indicated. Refer to text for recommended clearances. Refer to Fig. 32A and adjust remainder of valves.

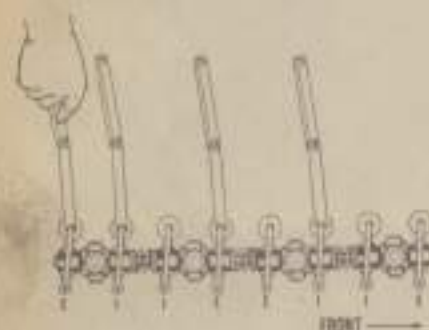


Fig. 32A—All non-diesel models. With number 4 piston at TDC on compression stroke, valve clearances (tappet gap) can be set on the four valves indicated. Refer also to Fig. 32.

ice in standard size and one oversize. Exhaust valve stem diameter is 0.3407-0.3417 for D-14 and D-15 models; 0.371-0.372 for D-17 models.

The positive type exhaust valve rotators require no maintenance, but the valve should be observed while engine is running to be sure that it rotates slightly. Renew the rotator on any exhaust valve that fails to turn.

Refer to paragraph 40 for setting tappet gap.

D-15 and D-17 Diesel

39. The inlet valves seat directly in the cylinder head and exhaust valves seat on renewable ring type inserts. Inlet valve seat and face angle is 45 degrees on D-15 diesel tractors and most D-17 diesel tractors prior to engine Serial Number 119938. Inlet valve face and seat angle is 30 degrees for D-17 diesel after engine Serial Number 119937. Exhaust valve face and seat angle is 45 degrees for all models.

Inlet valve seats having a 30 degree angle, can be narrowed by us-

ing 19 and 70-degree stones to obtain the desired seat width of 5/64 to 3/32-inch. Inlet and exhaust valve seats having a 45 degree angle, can be narrowed using 30 and 60 degree stones to obtain the desired seat width of 3/64 to 1/16 inch. Inlet and exhaust valve stem diameter is 0.309-0.310 inch.

Some D-15 and D-17 diesel models are equipped with inlet valve stem seals and seals should be renewed whenever the intake valves are removed for service. Remove old seals from intake valve guides. When re-installing valves, refer to Fig. 31 and install new intake valve seals as follows: Install intake valve in guide and place plastic sleeve (contained in seal kit) over stem as shown in view A. If sleeve extends over 1/16-inch below groove of valve stem, cut off excess length of sleeve. Lubricate the sleeve and, while holding against head of valve, push seal assembly down over sleeve and valve stem as shown in view B and view C. Rubber sleeve of seal should be pushed down over intake valve guide with two screw drivers as shown in view D, making sure that seal is tight against top of valve guide. Remove plastic sleeve from valve stem and when installing valve rotator, compress spring only far enough to install keepers. Compressing spring too far may damage seal.

Intake valves are equipped with positive type rotators. No maintenance of rotators is required, but valves should be observed while engine is running to be sure that each is rotating slightly in a counter-clockwise direction. Renew the rotator of any intake valve that fails to turn.

Refer to paragraph 40 for setting tappet gap.

TAPPET GAP ADJUSTMENT

All Models

40. Tappet gap should be set but to the following clearances.

| | | | |
|-----------------|-------------------|-------|-------------|
| D-14 | Inlet and exhaust | ..... | 0.012-0.014 |
| D-15 Non-Diesel | Inlet | ..... | 0.008-0.010 |
| | Exhaust | ..... | 0.014-0.016 |
| D-15 Diesel | Inlet | ..... | 0.010 |
| | Exhaust | ..... | 0.019 |
| D-17 Non-Diesel | Inlet and exhaust | ..... | 0.012-0.014 |

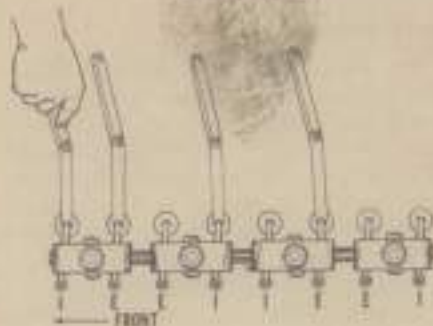


Fig. 33—D-15 diesel. With number 1 piston at TDC on compression stroke, valve clearances (tappet gap) can be set on the four valves indicated. Clearance for inlet valves (I) should be 0.010 inch hot; 0.019 inch hot for exhaust valves (E). Refer to Fig. 33A and adjust remainder of valves.

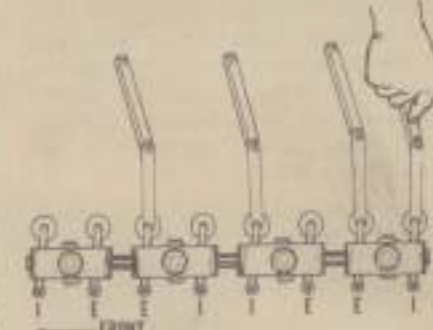


Fig. 33A—D-15 diesel. With number 4 piston at TDC on compression stroke, valve clearances (tappet gap) can be set on the four valves indicated. Refer also to Fig. 33.

| | | | |
|-------------|---------|-------|-------|
| D-17 Diesel | Inlet | ..... | 0.010 |
| | Exhaust | ..... | 0.019 |

Two-position adjustment of all valves is possible as shown in Figs. 22, 22A, 33, 33A, 34 and 34A. To make the adjustment, turn crankshaft to No. 1 cylinder TDC (non-diesel marked on flywheel; diesel marked on crankshaft pulley). If No. 1 piston is on compression stroke, both front rocker arms will be loose and both rear arms will be tight; adjust the valves indicated in Fig. 32 for all non-diesel models, Fig. 33 for D-15 diesel engines or Fig. 34 for D-17 Diesel models. If rear piston is on compression stroke, both front rocker arms will be tight and both rear rocker arms will be loose; adjust the valves indicated in Fig. 32A for all non-diesel models, Fig. 33A for D-15 diesel engines or Fig. 34A for D-17 diesel models. After adjusting four valves (six valves for D-17 diesel), turn the crankshaft one complete revolution until TDC marks are again aligned and adjust the remaining valves.

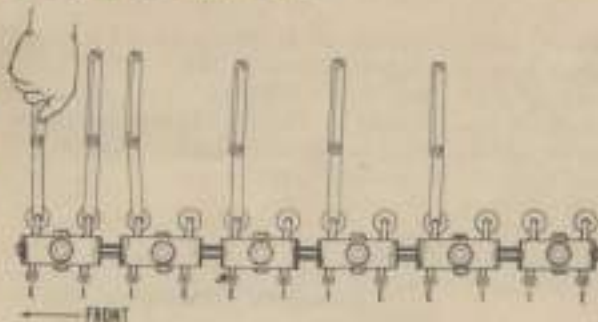


Fig. 34 — D-17 diesel. With number 1 piston at TDC on compression stroke, valve clearances (trapper gap) can be set on the six valves indicated. Clearance for inlet valves (I) should be 0.010 inch hot; 0.019 inch hot for exhaust valves (E). Refer to Fig. 34A and adjust remainder of valves.

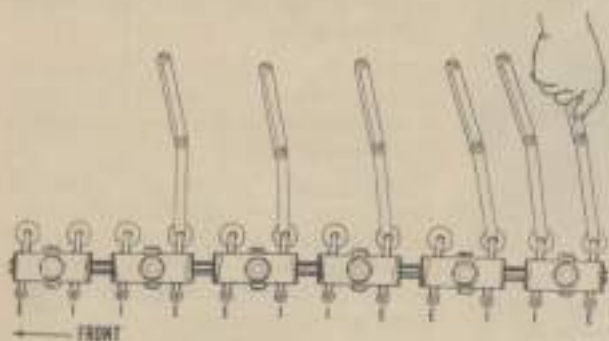


Fig. 34A — D-17 diesel. With number 6 piston at TDC on compression stroke, valve clearances (trapper gap) can be set on the six valves indicated. Refer also to Fig. 34.

VALVE GUIDES

D-14 and D-15 Non-Diesel

41. Intake and exhaust valve guides should be renewed if valve stem to guide clearance exceeds 0.008. Press new guides into cylinder head until top ends of guides are flush with machined rocker arm cover gasket surface. Check fit of valves in guides and ream guides, if necessary to provide 0.0023-0.004 clearance between guides and intake valve stems and 0.0023-0.0043 clearance between guides and exhaust valve stems. New valve guide inside diameter should be 0.344-0.345.

D-17 Non-Diesel

42. Valve guides should be renewed if clearance between stems and guides exceeds 0.008. Intake and exhaust valve guides are not interchangeable. New exhaust valve guides should be pressed into head until top of guide is flush with the machined rocker cover gasket surface of the cylinder head. Top of inlet valve guide should be $\frac{1}{8}$ -inch below the machined rocker cover gasket surface. Both intake and exhaust valve guides should be reamed to an inside diameter of 0.3745-0.3753 which should provide 0.0025-0.0045 clearance between valve stem and guide.

Diesel

43. Valve guides should be renewed if clearance between valve stems and guides exceeds 0.008. Intake and exhaust valve guides are not interchangeable. New intake and exhaust valve guides should be pressed into cylinder head until top of guides are $\frac{5}{16}$ -inch above the machined rocker cover gasket surface. The inlet valve guides are longer than guides for exhaust valves. Both intake and exhaust valve guides should be reamed to provide 0.0025-0.0045 clearance between the guides and the 0.3090-0.3100 diameter valve stems. Note: Late production intake valve guides are machined for valve stem seals.

VALVE SPRINGS

Non-Diesel

44. The interchangeable intake and exhaust valve springs should be renewed if they are rusted, distorted or fail to meet the following test specifications:

D-14 and D-17 Non-Diesel

Spring free length..... $2\frac{1}{4}$ inches
Renew if less than..... $2\frac{3}{4}$ inches
Pounds pressure @ $1\frac{1}{4}$ inches... 33-39
Pounds pressure @ $1\frac{1}{8}$ inches... 55-65

D-15 Non-Diesel

Spring free length
(new) $2\text{-}31/64$ inches
Renew if free length is
less than $2\text{-}27/64$ inches
Pounds pressure
@ $1\text{-}35/64$ inches 47-53
Pounds pressure
@ $1\text{-}31/64$ inches 75-85

D-17 Diesel (Prior to Engine Serial No. 119938 Except Serial No. 117087 through 117104)

45. The interchangeable intake and exhaust valve springs should be renewed if they are rusted, distorted or fail to meet the following test specifications:

Pounds pressure @ 1.758 in. 40-45
Pounds pressure @ 1.412 in. 86-92
Spring free length..... $2\frac{3}{4}$ inches

D-15 Diesel and Late D-17 Diesel

46. Intake and exhaust valve springs are not interchangeable. Install stamped steel valve spring dampener with flange between spring and cylinder head. Renew valve springs if they are rusted, distorted, or fail to meet the following test specifications:

INTAKE VALVE SPRINGS

Pounds pressure @ 1.584 in. . . 40-45
Pounds pressure @ 1.240 in. . . 86-92
Spring free length $1\frac{1}{2}$ in.
Renew if free length is
less than $1\text{-}17/32$ inches

EXHAUST VALVE SPRINGS

Pounds pressure @ 1.786 in. . . 40-45
Pounds pressure @ 1.412 in. . . 86-92
Spring free length $2\frac{1}{8}$ in.
Renew if free length is
less than $1\text{-}31/32$ inches

CAM FOLLOWERS

Non-Diesel

47. The mushroom type cam followers (tappets) ride directly in unbushed cylinder block bores and can be removed after removing the camshaft as outlined in paragraph 65 or 66. Cam followers are available in standard size only and followers and/or block should be renewed if clearance between followers and bores is excessive.

Diesel

48. The 0.5600-0.5605 diameter mushroom type cam followers (tappets) operate directly in unbushed

cylinder block bores with a suggested clearance of 0.0010-0.0025. Maximum allowable clearance is 0.0035.

The cam followers may be removed after removing the camshaft as outlined in paragraph 58. Cam followers are available in standard size only.

ROCKER ARMS

D-14 and D-15 Non-Diesel

49. R&R AND OVERHAUL. Rocker arms and shaft assembly can be removed after removing the right hood, rocker arm cover, oil line from head to shaft and the four retaining nuts.

Maximum allowable clearance between rocker arms and shaft is 0.010. If clearance exceeds 0.010, renew the worn part. Rocker arms are offset and must be installed with valve stem end of arm offset toward the nearest shaft support.

Renew corks in each end of rocker arm shaft if the corks are loose or damaged. Refer to paragraph 40 for adjusting valve clearance (tappet gap).

D-17 Non-Diesel

50. R&R AND OVERHAUL. Rocker arms and shaft assembly can be removed after removing the right hood panel, rocker arm cover, oil line to rocker arm shaft and the four retaining nuts.

To disassemble the rocker arm assembly, remove the cotter pin and washer from each end of shaft; then slide rocker arms, shaft supports and springs from shaft.

The valve stem contact surface of the rocker arms can be resurfaced, but the surface must be kept parallel to rocker arm shaft and original radius maintained. Desired clearance between rocker arm and shaft is 0.002-0.003. If clearance exceeds 0.008, renew the rocker arm and/or shaft. Rocker arm bushings are not available separately from rocker arm. The intake valve rocker arms can be identified by a milled notch located on the arm upper surface between the shaft and valve stem end. Reinstall rocker arm shaft with the oiling holes toward the cylinder head. Renew cork plugs in each end of rocker arm shaft if loose or damaged.

Refer to paragraph 40 for adjusting valve tappet gap.

51. ROCKER ARM Baffle. Non-diesel D-17 engines are fitted with a baffle over the rocker arms to prevent oil from splashing against the intake valve stems. At tractor Serial No. D17-24001, six 1/8-inch holes were incorporated in the baffle to prevent loss of oil at the breather. It is suggested that these holes be drilled in the baffle on prior serial numbered

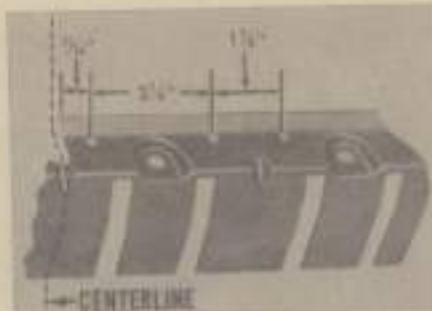
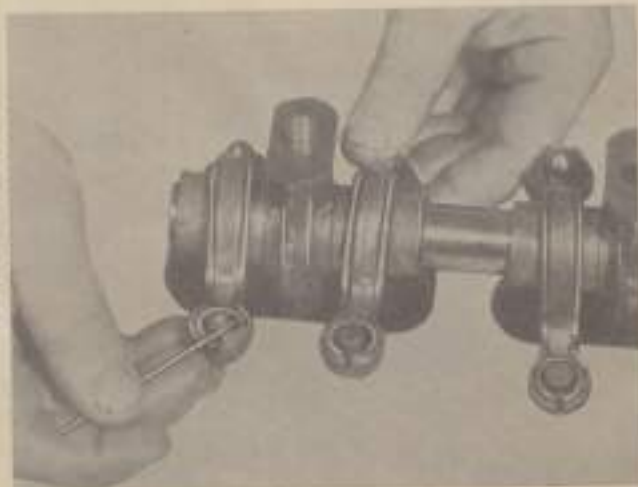


Fig. 35.—Rocker arm baffle is used on non-diesel D-17 engines to keep excessive amount of oil from valve stems. Six 1/8-inch holes should be drilled as shown in early production baffles to prevent oil from being splashed out of breather. Top of baffle must contact rocker arm cover.



Fig. 36.—Diesel engine rocker arm assembly is lubricated via the slotted stud (S). An early D-17 model is shown.

Fig. 37.—On the diesel engines, the rocker arms are fitted with reusable type valve stem contact buttons which can be removed after extracting the retaining stop rings as shown.



tractors if oil leakage at the breather is encountered. Refer to Fig. 35 for hole locations. Lip of baffle should be straight and contact rocker arm cover firmly when both are in position on engine.

Diesel

52. R&R AND OVERHAUL. Rocker arms and shaft assembly can be removed after removing the right hood side panel and rocker arm cover; then removing the retaining cap screws and stud nuts.

NOTE: On Late models, it will be necessary to remove the dry type air cleaner assembly to gain clearance for removal of rocker arm cover.

The hollow rocker arm shaft is drilled for lubrication to each rocker arm bushing. Lubricating oil to the drilled cylinder head passage and slotted oil stud (S—Fig. 36) is supplied by an external oil line which is connected to the main oil gallery on left side of engine. If the slotted stud is tight in the cylinder head and the end of stud is above the drilled passage, it is not necessary that the slot be in line with the passageway. However, this should be checked and if the end of the stud is lower than the passageway, be sure that the slot in the stud is in line with the drilled passage. If oil does not flow from the hole in the top of each rocker arm, check for foreign material in the external oil line or in the cylinder head passage.

The procedure for disassembling and reassembling the rocker arms and shaft unit is evident. Check the rocker arm shaft and bushings in rocker arms for excessive wear. Maximum allowable clearance between the shaft and rocker arm bush-

ings is 0.005. When installing new bushings, be sure that hole in bushing is aligned with hole in rocker arm and ream the bushings to provide a clearance of 0.001-0.002 between bushing and rocker arm shaft. Install rocker arm shaft with oil metering holes toward push rods.

NOTE: Rocker arm bushings are not available separately from rocker arm after D-15 engine Serial Number 119737 and D-17 engine Serial Number 119937. Renew complete rocker arm assembly if bushing is worn excessively.

Inspect the valve stem contact button in the end of each rocker arm for being mutilated or excessively loose. If either condition is found, renew the contact button. Extract the button retaining snap ring as shown in Fig. 37 and remove the button and oil wick. Install new oil wick and button and test the button for a free fit in the rocker arm socket. If button tends to bind in the socket, use a fine lapping compound and hand lap the mating surfaces.

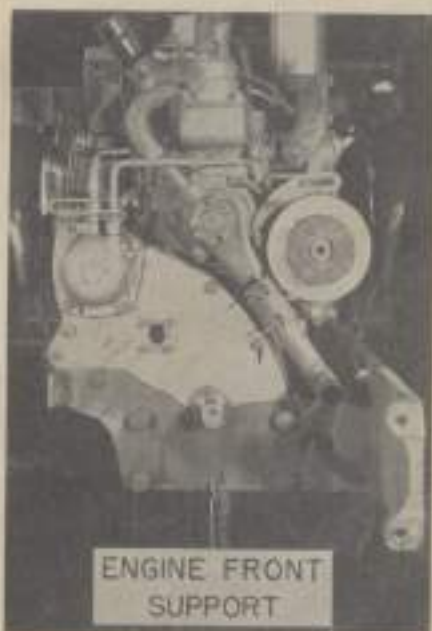


Fig. 38 — Camshaft thrust cover removed for installation of relief valve assembly and camshaft thrust assembly (Fig. 39).

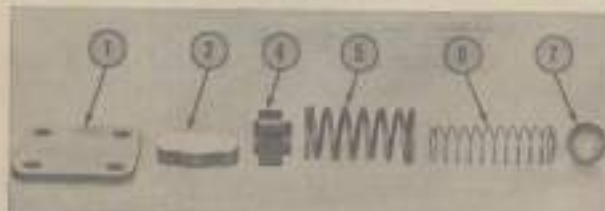


Fig. 39 — Removed oil pressure relief valve and camshaft thrust assembly. See Fig. 52 for legend.

TIMING GEAR COVER AND CRANKSHAFT FRONT OIL SEAL

D-14 and D-15 Non-Diesel

53. REMOVE AND REINSTALL. To remove the timing gear cover, first perform a front split as outlined in paragraph 13, and proceed as follows: Remove fan, governor housing and oil pan (sump). After removing the two Allen head set screws, use a suitable puller and remove crankshaft pulley. Remove the camshaft thrust cover and withdraw the camshaft thrust assembly and the engine oil pressure relief valve assembly. Refer to Fig. 29. Remove the engine front support, then unbolt and remove the timing gear cover.

To renew crankshaft front oil seal, proceed as follows: After removing timing gear cover, remove old seal from cover and reinstall timing gear cover loosely without seal. Center timing gear cover on crankshaft with tool as shown in Fig. 40; then, tighten timing gear cover cap screws while centering tool is in place. Remove centering tool, place seal expander over end of crankshaft as shown in Fig. 41 and slide seal on shaft with lip of seal to rear. Then, drive seal into timing gear cover with centering tool which is also a seal driver. As no dowel pins are used to properly locate timing gear cover, care must be taken in centering cover to crankshaft as described to prevent oil leakage.

D-17 Non-Diesel

54. R&R TIMING GEAR COVER. To remove the timing gear cover, first perform a front split as outlined in paragraph 13; then, proceed as follows: Disconnect wires from generator and remove the generator adjusting strap and fan belt. Remove the crankshaft pulley; then, unbolt and remove the engine front support and generator as a unit. Disconnect the carburetor link (3—Fig. 85) from the cross shaft (30) and the control rod from the governor control shaft (2). Remove the oil pan as outlined in paragraph 91. To gain clearance, unbolt and remove the water pump; then, unbolt and remove timing gear cover. Note: An alternate method is

to remove the stud bolts extending through timing gear cover and turn cover to clear water pump rather than to remove water pump for clearance.

The governor linkage can be overhauled or renewed as necessary and the crankshaft front oil seal may be renewed at this time.

Reinstall the cover by reversing removal procedure. Adjust camshaft end play to 0.007-0.010, after timing gear cover is installed, as follows: Loosen the adjusting screw lock nut located on front of timing gear cover and turn the adjusting screw in until it solidly contacts end of camshaft; then, back screw out $\frac{1}{8}$ -turn and tighten lock nut while holding adjusting screw in this position.

55. CRANKSHAFT FRONT OIL SEAL. The crankshaft front oil seal can be renewed in a conventional manner after first removing the timing gear cover as outlined in paragraph 54. Sealer should be applied to the outer rim of seal.



Fig. 40—Timing gear cover on D-14 and D-15 non-diesel engines is not located with dowel pins. Alignment tool (3) must be used to properly position timing gear cover to crankshaft before retaining cap screws are tightened. Seal is then installed as shown in Fig. 41.

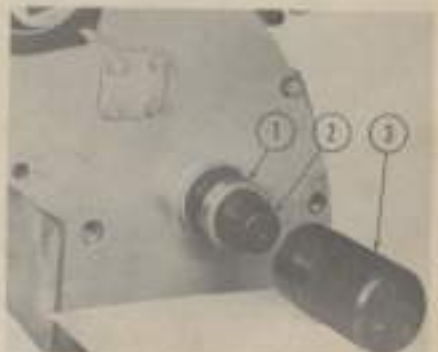


Fig. 41 — After timing gear cover on D-14 and D-15 non-diesel engines is installed (See Fig. 40), place seal protector (2) over end of crankshaft and drive seal (1) into cover with lip to inside using alignment tool (3) as a seal driver.



Fig. 42 — Diesel timing gear cover (2) as associated parts.

1. Crankshaft front oil seal
2. Timing gear cover
3. Engine front support plate
4. Gasket
- 4A. Gasket

D-15 and D-17 Diesel

56. R&R TIMING GEAR COVER.

To remove the timing gear cover, first perform a front split as outlined in paragraph 13; then, remove the fan belt, power steering pump drive belt if so equipped, and the crankshaft pulley retaining nut and pulley. The timing gear cover can now be unbolted and removed.

The crankshaft front oil seal (1—Fig. 42) should be installed with the lip facing rear. Apply gasket sealer to outside rim of seal before installing same in timing gear cover.

Reinstall cover by reversing the removal procedure taking care to install the four cover to oil pan cup screws and copper washers in the proper places.



Fig. 43—D-14 and D-15 non-diesel timing marks on camshaft gear and crankshaft gear. The governor and distributor drive gear, also shown, may be meshed in any position; ignition timing being made at distributor. Timing marks for D-17 non-diesel engines are similar.

NOTE: Copper sealing washers are not used on late production engines. On these engines, be sure to apply gasket sealer to the discs of the cup screws that extend through the engine oil pan.

57. CRANKSHAFT FRONT OIL SEAL. The crankshaft front oil seal can be renewed in a conventional manner after first removing the timing gear cover as outlined in paragraph 56. Gasket sealer should be applied to outer rim of seal.

TIMING GEARS

Non-Diesel

58. TIMING GEAR MARKS AND GEAR BACKLASH. Timing gears are properly meshed when the scribed lines on the camshaft gear and crankshaft gear are in register as shown in Fig. 43.

Check timing gear backlash while holding all end play from camshaft. Desired backlash is 0.002-0.006. Renew timing gears if backlash exceeds 0.010.

59. CAMSHAFT GEAR. The camshaft gear is keyed and press fitted to the camshaft and can be removed with a suitable puller after first removing the timing gear cover as outlined in paragraph 53 or 54.

Before installing, heat gear in hot oil or boiling water for 15 minutes; then, back-up camshaft with heavy bar while drifting heated gear on shaft. The gear should butt up against front camshaft journal. Make certain that timing marks are aligned as shown in Fig. 43.

NOTE: Less mechanics may prefer to remove the camshaft as outlined in paragraph 63 or 66; then, remove the gear from the shaft and install new gear in a press.

60. CRANKSHAFT GEAR. The crankshaft gear is keyed and press fitted to the crankshaft and can be removed by using a suitable puller after first removing the timing gear cover as outlined in paragraph 53 or 54.

Before installing, heat gear; then, back-up crankshaft with a heavy bar while drifting heated gear on shaft. Make certain that timing marks are aligned as shown in Fig. 42.

Diesel

61. TIMING GEAR MARKS AND GEAR BACKLASH. Timing gears are properly meshed when the punch marked tooth of the crankshaft gear is in register with the punch marked space between teeth on the camshaft gear and the punch marked space between teeth on the injection pump drive gear is in register with the punch marked tooth on the pump driven gear as shown in Fig. 44.

Desired backlash between camshaft gear and crankshaft gear is 0.001-0.005. Camshaft gear and/or crankshaft gear should be renewed if backlash exceeds 0.008. Gears are available in standard size only. Note: While checking gear backlash, be sure to hold all end play out of camshaft.

62. CAMSHAFT GEAR. It is recommended that the camshaft be removed from engine to remove and install



Fig. 44 — Diesel engine timing gears consist of camshaft and crankshaft gears and injection pump drive and driven gears. Timing marks should be aligned as shown.



Fig. 45 — Removing the camshaft thrust plate retaining cap screws. (Although a WD45 diesel engine is shown the method is the same for D-15 and D-17 diesel models.)

camshaft gear. After timing gear cover is removed as outlined in paragraph 56, proceed as follows: Remove rocker arm shaft assembly and push rods as outlined in paragraph 52. Unbolt and remove oil pan and oil pump. Pull injection pump driven gear and shaft from injection pump. Note: Fuel will flow from pump unless shut off valve has been closed and pump drained through timing window opening. Unbolt and remove the injection pump drive gear from front of camshaft gear. Pull each cam follower up against cylinder block with wooden dowel pins driven into the hollow followers and hold in that position with pincher type clothes pins. Working through the holes in the camshaft gear, remove the two cap screws retaining the camshaft thrust plate to cylinder block; then withdraw camshaft and gear assembly from front of engine.

Remove snap ring from in front of camshaft gear, then remove gear from shaft in a press or by using a suitable puller. Gear is keyed and press fitted to shaft.

Camshaft end play is controlled by the thrust plate that retains the camshaft assembly in the cylinder block. End play should be 0.003-0.008 and can be measured with a dial indicator, or when camshaft assembly is removed, end play can be measured with a feeler gage as shown in Fig. 46. If end play exceeds 0.014, worn thrust plate should be renewed or end play can be reduced by filing off the rear face of the camshaft gear as shown in Fig. 47.

Install thrust plate, Woodruff key, camshaft gear and snap ring on camshaft and reinstall the assembly by reversing removal procedures.



Fig. 46—To check the diesel engine camshaft end play, insert a feeler gage as shown between shaft journal and the thrust plate. The amount of end play is equal to the thickness of the maximum size feeler gage that can be inserted.

CAUTION: Both camshaft thrust plate retaining cap screws should be drilled through length of cap screw. Never substitute solid cap screws for this installation as lubricating oil for the timing gears must pass through the hollow cap screw in lower position. Be sure that timing marks are aligned as shown in Fig. 44 before installing camshaft thrust plate retaining cap screws.

63. CRANKSHAFT GEAR. The crankshaft gear is keyed and press fitted to the crankshaft. The gear can be removed by using a suitable puller after first removing the timing gear cover as outlined in paragraph 56.

New gear can be installed by heating it in oil for fifteen minutes prior to installation and drifting the heated gear on the crankshaft or by pressing gear on shaft using crankshaft pulley retaining nut and suitable washers and spacers. Be sure timing marks are aligned as shown in Fig. 44.

DIESEL INJECTION PUMP DRIVE AND DRIVEN GEARS

64. The diesel fuel injection pump drive and driven gears can be removed and reinstalled after the timing gear cover is removed as outlined in paragraph 56. The pump driven gear and shaft assembly is removed by pulling it from the fuel injection pump. Note: Fuel in the pump will drain out through the shaft opening unless fuel has been shut off and the pump drained by removing timing inspection cover on side of pump prior to removal of gear and shaft. The pump drive gear is retained to the camshaft gear by three wired cap screws and one dowel pin.



Fig. 47—Excessive diesel engine camshaft end play can be corrected by filing the required amount of metal from rear face of the camshaft gear hub. Refer to text.

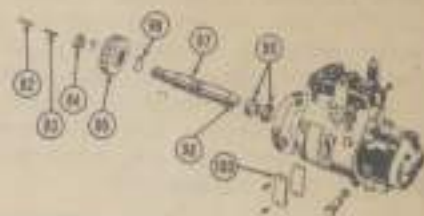


Fig. 48—Partially exploded view of the injection pump drive assembly used on diesel engines.

| | |
|---------------------|------------------------|
| 82. Thrust plunger | 87. Shaft |
| 83. Spring | 88. Off-center hole |
| 84. Nut | 88. Seals |
| 85. Pump drive gear | 100. Pump timing cover |
| 86. "O" ring | |

The injection pump driven gear can be removed from the pump shaft by removing the retaining nut and pressing shaft from gear. The two lip seals on the shaft should be renewed whenever the shaft is removed from the pump. Lip of each seal should be towards end of shaft (opposed).

To install pump driven gear and shaft unit, lubricate seals with Lubriplate or similar lubricant and insert shaft in pump with off-center hole on drive tang of shaft and off-center hole in pump rotor slot aligned. Carefully work the shaft into pump to avoid rolling lip of rear seal back. Note: If lip of seal is rolled back during installation, remove shaft and renew seal before proceeding further. The seal will have been damaged and early failure of seal will occur. Be sure drive tang of shaft enters drive slot in pump rotor. Place spring and plunger in front end of shaft.

To install pump drive gear, turn engine until timing marks on camshaft gear and crankshaft gear are aligned and secure pump drive gear with dowel pin and cap screws. Wire the cap screws as shown in Fig. 44. Be sure that the punch marked tooth of injection pump driven gear is in register with the punch mark between two teeth of the drive gear as shown in Fig. 44.

CAMSHAFT AND BUSHINGS

D-14 and D-15 Non-Diesel

The camshaft is carried by three 1.745-1.750 diameter bearing journals which have a normal clearance of 0.002-0.004 in the 1.752-1.753 diameter bushings. Shaft end play is automatically maintained by a spring loaded thrust plunger in front end of shaft and a thrust plate interposed between camshaft (8—Fig. 52) and the thrust cover (1).

65. R&R AND OVERHAUL. To remove the camshaft, first remove the timing gear cover as outlined in paragraph 53 and the rocker arms and

shaft assembly as outlined in paragraph 49; then remove the push rods. Before removing the camshaft, check the backlash of the timing gears and if more than 0.008 renew the gears as necessary. Raise the cam followers (tappets) from below and worm the camshaft out front of engine.

Check the oil pump driving pin (9—Fig. 52) and renew same if damaged or worn. The 1.749-1.750 diameter camshaft bearing journals have a normal clearance of 0.002-0.004 in the 1.752-1.753 diameter bushings. If bushing diameter exceeds 1.750, renew the bushings. If camshaft journals are worn, 0.0025 undersize bushings are available.

To renew bushings, the additional work of removing the engine oil pump as outlined in paragraph 93 is necessary. Drive out old bushings and install new ones with a piloted drift as follows: Drive rear bushing in $\frac{1}{4}$ -inch past flush with rear face of block, making certain oil hole in bushing is aligned with passage in block. The center bushing should be installed with $\frac{3}{8}$ -inch hole aligned with oil passage to center main bearing and $\frac{1}{4}$ -inch hole aligned with the passage toward right side of block. The front bushing should be installed flush with front face of block with oil hole aligned with oil passage. When installing camshaft, be sure pin in rear end of shaft engages slot in oil pump rotor and align timing marks as shown in Fig. 43.

D-17 Non-Diesel

66. CAMSHAFT. To remove the camshaft, first remove the timing gear cover as outlined in paragraph 54, the rocker arm shaft assembly as outlined in paragraph 50 and remove the push rods. Remove the oil pan and oil pump, hold tappets (cam followers) up to clear cams and withdraw camshaft from engine. The mushroom type cam followers can be removed at this time.

Clearance between the camshaft and the three split type camshaft bushings should be 0.002-0.004. Renew camshaft bushings and/or camshaft if clearance exceeds 0.006. Bushings are available in standard size and in 0.0025 undersize. Camshaft journal diameter is 1.874-1.875.

When reinstalling camshaft, make certain that all oil passages are clean. Reverse removal procedure to reinstall. Be sure to adjust camshaft end play as outlined in paragraph 54 after reinstalling timing gear cover.

NOTE: At engine Serial No. 17-19978, the oil pump driving gear on the camshaft was changed from 11 teeth to 14 teeth to increase oil pump capacity. Prior to this change, a $\frac{1}{4}$ -inch pipe plug was used to seal the oil passage at rear end of camshaft. After this change, the passage is sealed with a $\frac{3}{8}$ -inch steel ball pressed into rear end of shaft. Service camshafts have this steel ball packaged in a bag that is attached to the camshaft. Prior to installing new shaft, clean out the oil passageway and press the steel ball into passageway until flush with rear end of camshaft. **CAUTION:** Oil pump drive gear having 10 teeth must be used with camshaft having 11 tooth oil pump driving gear and an oil pump drive gear having 8 teeth must be used with camshaft having a 14-tooth oil pump driving gear.

67. CAMSHAFT BUSHINGS. To renew the camshaft bushings after removal of camshaft, it is necessary to remove flywheel which requires removal of engine from tractor. After removing the clutch and flywheel, drive the rear bushing out towards rear, forcing the expansion plug at rear of bore out with bushing.

Bushings are pre-sized and should be installed with a piloted driver. Make sure that oil holes in bushings are aligned with oil passages in the cylinder block bores. Minimum (standard) bushing diameter after installation should be 1.877. Bushings are also available in 0.0025 undersize for fitting with worn shafts. It will probably be necessary to finish grind the camshaft journals to use the 0.0025 undersize bushings. When installing the expansion plug in rear of block, be sure the drilled hole at rear of bushing is open, apply sealer to rim of plug and be sure that it seats tightly in the cylinder block.

NOTE: Prior to engine Serial No. 17-19978, center camshaft bushing had two oil holes and the end bushings had only one hole. On engine Serial No. 17-19970 and up, all three camshaft bushings are alike and have only one oil hole in each bushing. When servicing engines prior to Serial No. 17-19978, be sure that the bushing having two oil holes is used at center camshaft bearing bore and that both oil holes are aligned with the oil passages in the cylinder block.

Diesel

68. CAMSHAFT AND BEARINGS. The camshaft is supported in four precision steel backed rabbit lined bearings. The shaft journals have a normal operating clearance of 0.002-0.0046 in the bushings. If journal clearance exceeds 0.0065, the bushings and/or the camshaft should be renewed.

To remove the camshaft, follow procedure outlined in paragraph 82 for removal of camshaft gear.

To renew the camshaft bushings after removal of camshaft, the engine must be removed from the tractor and the flywheel, engine rear adapter plate and the soft plug behind the rear bushing must be removed.

New rear bushing should have 0.001-0.003 interference fit in bore of block and the three front bushings should have 0.002-0.004 interference fit. Although front bushing has the same diametrical dimensions as the two intermediate bushings, it is wider and the oil holes are spaced differently. Be sure that the oil holes in all bushings line up with the oil passages in the cylinder block.

Inside diameter of camshaft bearings after installation should be as follows:

Front, second & third 2.0010-2.0028
No. 4 (rear) 1.2510-1.2528

Although camshaft bearings are pre-sized, it is highly recommended that bearings be checked after installation for localized high spots. Camshaft bearing journals should have a normal operating clearance in bearings of 0.002-0.0046.

Use Permatex or other suitable sealer when installing plug at rear of camshaft bushing bore in rear face of cylinder block.

ROD AND PISTON UNITS

D-14 and D-15 Non-Diesel

69. Connecting rod and piston units are removed from above after removing the cylinder head as outlined in paragraph 35 and the oil pan. Connecting rods are offset; numbers 1 and 3 having long part of bearing towards flywheel; numbers 2 and 4 having long part of bearing toward timing gears. Tighten connecting rod nuts to 35-40 Ft.-Lbs. of torque and install pal nuts. Tighten pal nuts finger tight plus $\frac{1}{4}$ turn.

D-17 Non-Diesel

70. Connecting rod and piston assemblies are removed from above after removing the cylinder head, oil pan and connecting rod caps.

Rods should be installed with piston pin clamping screw on camshaft side of engine and cylinder numbers on rod and cap aligned (tang of bearing inserts must be to same side of rod and cap assembly). Rods are offset in pistons; refer to paragraph 75 and to Fig. 49. Tighten the connecting rod nuts to a torque of 45-55 Ft.-Lbs.

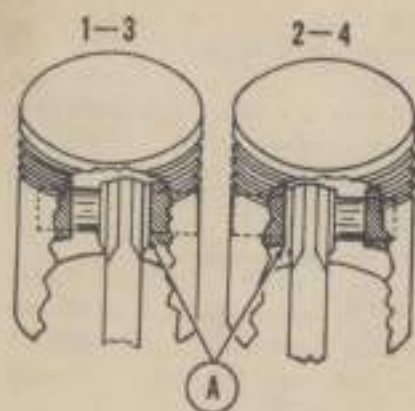


Fig. 49 — D-17 non-diesel piston pins are of the locked-in rod type. Numbers 1 and 3 units are assembled as shown at the left. Numbers 2 and 4 units are assembled as shown at the right.

Diesel

71. Piston and connecting rod units are removed from above after removing cylinder head, oil pan and connecting rod caps.

Cylinder numbers are stamped on the connecting rod and cap. When re-installing rod and piston units, make certain that the cylinder identifying numbers are in register and face away from the camshaft side of engine. (Both bearing insert tangs must be towards same side of rod and cap assembly.)

Tighten the connecting rod nuts to a torque of 40-50 Ft.-Lbs. and install new cotter pins.

PISTONS, LINERS (SLEEVES) AND PISTON RINGS

Non-Diesel

72. The cam ground aluminum pistons are fitted with three compression rings and one segment type oil control ring. Pistons and rings are available in standard size only.

When assembling the pistons to connecting rods, refer to paragraph 74 or 75.

Compression rings should be installed with the side of ring marked "T" or "TOP" towards top of piston. To install the segment type oil ring, proceed as follows: Install expander in ring groove with ends butted together above either end of piston pin. Install top steel rail with end gap 90 degrees away from expander joint. Install lower steel rail with end gap 180 degrees away from top rail end gap. Be sure that ends of expander are butted together and not overlapped.

After removing piston and connecting rod assembly, use suitable pullers to remove the wet type cylinder liners (sleeves) from cylinder block. Clean all sealing and mating surfaces of block prior to installing new sleeve. Lubricate the sealing rings with thinned white lead or a soap lubricant and carefully push sleeves into place. Top of sleeve should stand out 0.002-0.005 above top of cylinder block on D-14 and D-15 models; 0.000-0.003 above top of block on D-17 models. Excessive stand out will cause leakage at head gasket.

Check pistons, rings and sleeves against the following specifications:

| | |
|---|---------------|
| MODEL D-14 | |
| Ring end gap | 0.007-0.017 |
| Ring land clearance | 0.0015 |
| Cylinder liner ID | 3.4995-3.5005 |
| Wear limit | 3.5115 |
| Piston skirt clearance (bottom of skirt-right angles to piston pin) | 0.0025-0.0035 |

| | |
|---|---------------|
| MODEL D-15 | |
| Ring end gap— | |
| Compression | 0.009-0.014 |
| Oil ring | 0.007-0.017 |
| Ring land clearance | |
| Compression | 0.0015-0.0035 |
| Oil ring | 0.001-0.003 |
| Cylinder liner ID | 3.4995-3.5005 |
| Wear limit | 3.5105 |
| Piston skirt clearance (bottom of skirt-right angles to piston pin) | 0.0015-0.003 |

| | |
|---|---------------|
| SERIES II D-15 | |
| Ring end gap— | |
| Compression | 0.009-0.014 |
| Oil ring | 0.007-0.017 |
| Ring land clearance— | |
| Compression | 0.0015-0.0035 |
| Oil ring | 0.001-0.003 |
| Cylinder liner ID | 3.6245-3.6255 |
| Wear limit | 3.6355 |
| Piston skirt clearance (bottom of skirt-right angles to piston pin) | 0.0015-0.003 |

| | |
|---|---------------|
| MODEL D-17 | |
| Ring end gap | |
| Compression rings | 0.009-0.017 |
| Oil ring (steel rails) | 0.015-0.055 |
| Ring side clearance | |
| Compression rings | 0.0015-0.0035 |
| Oil ring (segment type) | 0-0.065 |
| Cylinder liner ID, new | 4.000-4.001 |
| Liner stand-out | 0-0.003 |
| Renew if wear at top of liner exceeds | 0.011 |
| Piston skirt diameter | |
| Parallel to pin | 3.989 |
| At right angle to pin | 3.998 |
| Piston skirt to liner clearance | |
| At right angle to piston pin | 0.002-0.003 |

Diesel

73. The cam ground aluminum pistons are fitted with three compression rings, one segment type oil ring above the piston pin and one scraper type oil control ring below the piston pin. Pistons and rings are available in standard size only.

NOTE: Early production models were equipped with two scraper type oil rings instead of one scraper type and one segment type ring; however, when servicing these tractors, a segment type ring can be used in the fourth ring groove as on later production models.

Install compression rings with side marked "TOP" towards top of piston. To install the three piece segment type oil ring, place expander in groove with ends butted together above either end of piston pin. While holding expander in position, install top steel rail with end gap 90 degrees away from ends of expander. Then, install the bottom steel rail with end gap 180 degrees away from end of top rail. Be sure that the ends of the expander remain butted together and do not overlap. Install the scraper type oil ring in the bottom ring groove with scraper edge of ring down.

With the piston and connecting rod assembly removed from the block, use a suitable puller to remove the wet type cylinder sleeve. Clean and lubricate all sealing and mating surfaces of sleeve and block and renew sealing "O" rings. Use soap or thinned white lead as lubricant. Top of cylinder sleeve should be from 0.002 below to 0.002 above top surface of cylinder block when sleeves are installed. If top of sleeve is more than 0.002 below top of block, sleeves with flange 0.020 thicker than standard are available for service and may be installed by machining counterbore in block out to proper depth to provide proper stand-out of -0.002 to +0.002.

Check pistons, rings and sleeves against the following specifications:

D-15 Diesel

| | |
|---------------------------------------|---|
| Piston Ring Side Clearance— | |
| Top | 0.003-0.0045 |
| Wear limit | 0.008 |
| 2nd and 3rd | 0.002-0.004 |
| 4th and 5th | 0.0015-0.0035 |
| Ring End Gap— | |
| Top | 0.007-Minimum |
| 2nd and 3rd | 0.014 Minimum |
| 4th and 5th | 0.007 Minimum |
| Piston Skirt to Sleeve (liner) | |
| Clearance | Desired 0.004-0.0065 (Maximum 0.007) |

D-17 Diesel

Piston Ring Side Clearance:

| | |
|-----------------------------|---------------------|
| Top ring | Desired 0.003-0.005 |
| | Maximum 0.007 |
| 2nd & 3rd, desired | 0.002-0.004 |
| 4th (segment type), desired | 0-0.0055 |
| 5th, desired | 0.0015-0.0035 |

Hing Eng Gap:

| | |
|------------------------------|-------------|
| Top compression | 0.008-0.016 |
| 2nd & 3rd compression | 0.015-0.023 |
| 4th (side rails only) (min.) | 0.014 |
| 5th oil | 0.008-0.016 |

Piston skirt to sleeve clearance:

| | |
|-------------------|--------------|
| Desired | 0.004-0.0065 |
| Maximum allowable | 0.009 |

Renew cylinder sleeve if wear at top of ring travel (taper) exceeds 0.007. Inside diameter of new sleeve is 3.5623-3.5630.

PISTON PINS

D-14 and D-15 Non-Diesel

74. The 0.8133-0.8135 diameter piston pins are available in standard size only and have a clearance of 0.0004-0.0006 (at 70° F.) in the 0.8139 piston pin bosses. Piston pins are locked in the connecting rod by a clamping cap screw. Be sure rod and piston pin are centered in piston before tightening the clamp screw to 33-40 Ft.-Lbs. of torque.

D-17 Non-Diesel

75. The 0.8893-0.8895 diameter piston pins are available in standard size only. Desired clearance between piston pin and piston pin bores in piston is 0.0005-0.0007 at 70° F. Pins are retained by the clamp type connecting rods.

Pistons and rods should be assembled with the rods offset away from the nearest main bearing journal. Assemble connecting rod and piston units as follows: On all four units, the connecting rod clamp screw should be towards the camshaft side of engine. Refer to Fig. 49. On the number one and three units, hold connecting rod against the rear piston pin boss (A) and the rear end of the piston pin slightly below flush with piston skirt while tightening rod clamp screw. On the number two and four units, hold connecting rod against the front piston pin boss (A) and the front end of piston pin slightly below flush with piston skirt while tightening rod clamp screw. Tighten all rod clamp screws to a torque of 25 Ft.-Lbs.

NOTE: Piston and connecting rod unit should be held by a pin or rod inserted through piston pin while tightening rod clamp screw to avoid possible twisting of connecting rod.

Diesel

76. The full floating type piston pins are retained in piston pin bosses by snap rings and are available in standard size only. Check piston pin fit against values which follow:

D-15

| | |
|---|-----------------|
| Piston pin bore | |
| in rod bushing | 1.0001-1.0006 |
| Piston pin bore | |
| in piston | 0.99985-1.00005 |
| Piston pin diameter | 0.99955-0.99975 |
| Desired clearance between pin and rod bushing | |
| at 70 degrees F. | 0.00035-0.00135 |

| | |
|--|---------------|
| Desired clearance between pin and bore in piston | |
| at 70 degrees F. | 0.0001-0.0005 |

D-17

| | |
|---|-----------------|
| Piston pin bore | |
| in rod bushing | 0.9999-1.00004 |
| Piston pin bore | |
| in piston | 0.99985-1.00005 |
| Piston pin diameter | 0.99935-0.99975 |
| Desired clearance between pin and rod bushing | |
| at 70 degrees F. | 0.00015-0.00085 |

| | |
|--|---------------|
| Desired clearance between pin and bore in piston | |
| at 70 degrees F. | 0.0001-0.0005 |

Maximum allowable clearance between piston pin and rod bushing and/or bore in piston is 0.002 for both D-15 and D-17 diesel models.

CONNECTING RODS AND BEARINGS

Non-Diesel

77. Connecting rod bearings are of the non-adjustable precision insert type and are renewable from below after removing the oil pan and rod bearing caps.

When renewing bearing inserts, be sure that the tangs on the inserts engage the milled notches in connecting rod and cap and that rod and cap are assembled so that the insert tangs are both on the same side of the assembly. Bearing inserts are available in under-sizes of 0.001 and 0.0025 as well as standard.

Check the bearing inserts and crankshaft connecting rod journals against the following specifications:

D-14

| | |
|-----------------------------|---------------|
| Rod journal diameter (std.) | 1.9365-1.9375 |
| Rod side clearance | 0.006-0.011 |
| Rod bearing clearance | 0.0006-0.0027 |
| Rod nut torque (Ft.-Lbs.) | 35-40 |

D-15

| | |
|-----------------------------|-------------|
| Rod journal diameter (std.) | 1.936-1.937 |
| Rod side clearance | 0.006-0.011 |
| Rod bearing clearance | 0.001-0.003 |
| Rod nut torque (Ft.-Lbs.) | 35-40 |

D-17

| | |
|-----------------------------|-------------|
| Rod journal diameter (std.) | 2.374-2.375 |
| Rod side clearance | 0.004-0.006 |
| Bearing clearance | 0.001-0.003 |
| Rod nut torque (Ft.-Lbs.) | 45-55 |

Diesel

78. Connecting rod bearings are of the non-adjustable precision insert type and are renewable from below after removing the oil pan and connecting rod caps.

When renewing bearing inserts, be sure that the tangs on the inserts engage the milled notches in connecting rod and cap and that rod and cap are assembled so that the insert tangs are both on the same side of the assembly. Inserts are available in under-sizes of 0.002, 0.010, 0.020 and 0.040 as well as standard.

Check the bearing inserts and crankshaft connecting rod journals against the following specifications:

| | |
|------------------------------|---------------|
| Rod journal diameter (std.) | 1.9975-1.9985 |
| Rod side clearance (desired) | 0.003-0.009 |
| Max. allowable | 0.015 |
| Bearing clearance (desired) | 0.0011-0.0036 |
| Max. allowable | 0.006 |
| Rod bolt torque (Ft.-Lbs.) | 40-50 |

CRANKSHAFT AND BEARINGS

D-14 and D-15 Non-Diesel

79. The crankshaft is supported in three non-adjustable, slip-in, precision type bearing inserts which can be renewed after removing oil pan and main bearing caps. Crankshaft end play of 0.004-0.006 is controlled by the flanged rear main bearing inserts. Check the 2.748-2.749 main journals for wear, out-of-round or taper and if any of these conditions exceed 0.004, renew crankshaft. Main bearing oil clearance is 0.002-0.004. Install inserts with projections engaging the machined slots and with slots in cap and block on the same side of engine. Bearing cap retaining cap screws should be tightened to 90-95 Ft.-Lbs. of torque.

D-17 Non-Diesel

80. The crankshaft is supported in three non-adjustable precision insert type bearings.

To renew the main bearing inserts, proceed as follows: Remove engine as outlined in paragraph 33. Unbolt and remove the starting motor, oil pan, clutch assembly, flywheel and engine rear adapter plate. All main bearing caps may now be removed.

To remove the crankshaft, first remove the engine as outlined in paragraph 33. Then, proceed as follows: Unbolt and remove starting motor, oil pan, oil pump and tube, clutch assembly, flywheel, engine rear adapter plate and timing gear cover. After removing the connecting rod bearing caps and main bearing caps, the crankshaft can be removed.

Crankshaft end play is controlled by the center main bearing inserts. Desired end play is 0.0045-0.013. Desired main bearing running clearance is 0.0014-0.0035. Main journal standard diameter is 2.9995-3.000. Bearing inserts are available in undersizes of 0.001 and 0.0025 as well as standard. Renew main bearing inserts if end play exceeds 0.013 or bearing running clearance is excessive. When installing bearing inserts, be sure that tangs on each insert engage milled notch in block or cap and that caps are installed so that both bearing insert tangs are on same side of engine. Tighten the main bearing cap screws to a torque of 130-140 Ft.-Lbs.

Diesel

81. The crankshaft is supported in precision insert type main bearings. The main bearing inserts can be renewed after removing the oil pan, oil pump, oil tube and main bearing caps. Five main bearings are used on D-15 engines and seven are used in D-17 engines.

Crankshaft end play is controlled by the flanges on the center main bearing inserts. Desired end play is 0.003-0.009. Desired main bearing running clearance is 0.0013-0.004. Renew all main bearing inserts if crankshaft end play exceeds 0.015 or bearing clearance exceeds 0.007. Inserts are available in undersizes of 0.002, 0.010, 0.020 and 0.040 as well as standard. Main bearing journal standard diameter is 2.4970-2.4980. When renewing bearing inserts, be sure that tangs on inserts engage the milled notches in block and cap and that cap is installed so that both bearing insert

tangs are on same side of engine. Center main bearing cap is dowelled to block. Tighten the main bearing cap screws to a torque of 120-130 Ft.-Lbs.

To remove crankshaft, first remove engine as outlined in paragraph 34. Remove clutch, flywheel and engine rear adapter plate. Remove valve cover, rocker arm shaft assembly and push rods. Remove oil pan, oil pump, oil tube and rod and main bearing caps. Remove timing gear cover and injection pump drive and driven gears. Unbolt camshaft thrust plate, withdraw camshaft and remove the engine front plate. Lift crankshaft from engine.

CRANKSHAFT OIL SEALS**D-14 and D-15 Non-Diesel**

82. **FRONT SEAL.** The crankshaft front oil seal is located in the timing gear cover and can be renewed after removing the timing gear cover as outlined in paragraph 53.



Fig. 50—On D-14 and D-15 non-diesel models, the crankshaft rear oil seal is contained in the seal retainer (SR). Oil pump (OP) can be removed after removing the flywheel.

83. **REAR SEAL.** The crankshaft rear oil seal is contained in the seal retainer bolted to rear face of engine block. To renew seal, first remove the flywheel as outlined in paragraph 89. Remove the two cap screws retaining oil pan to seal retainer and loosen the remaining oil pan cap screws. Then unbolt and remove retainer from rear of engine. See Fig. 50.

Apply sealer to outside diameter of the seal; then press seal in retainer with lip toward front of engine.

D-17 Non-Diesel

84. **FRONT SEAL.** The crankshaft front oil seal is located in the timing gear cover and can be renewed as outlined in paragraph 53.

85. **REAR SEAL.** Lower half of oil seal is located in the rear main bearing cap and upper half is located in seal retainer that is attached to rear face of cylinder block. Renewal of rear seal requires removal of engine from tractor. Then, remove clutch, flywheel, engine rear adapter plate and oil pan. Unbolt and remove rear main bearing cap and seal retainer.

Do not trim ends of seal as the seal will compress when bearing cap is tightened. Be sure that oil seal contact surface on crankshaft is smooth and true. Apply gasket sealer to back of seal and seal groove; be careful to avoid getting gasket sealer on face of seal. Lubricate seal and reassemble by reversing removal procedure.

Diesel

86. **FRONT SEAL.** The crankshaft front oil seal is located in the timing gear cover and can be renewed as outlined in paragraph 57.

87. **REAR SEAL.** The crankshaft rear oil seal is installed in the adapter plate at rear of engine. The latest seal available for service consists of two parts; a seal retainer with an integral lip type inner seal and a

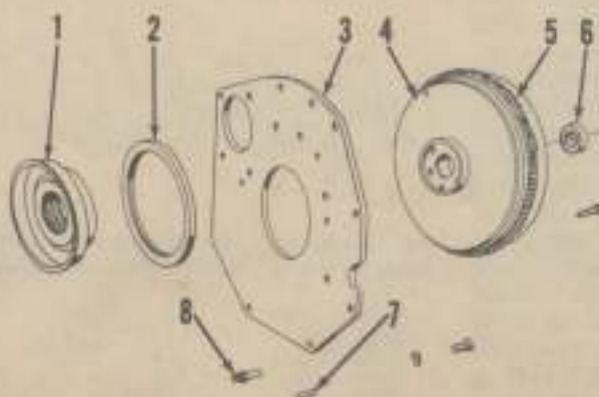


Fig. 51—Exploded view of D-17 diesel rear oil seal, plate and flywheel. Two-piece rear oil seal used on earlier production is serviced by one-piece seal (1) shown. D-15 diesel models are similar.

1. Rear oil seal
2. Seal ring
3. Adapter plate
4. Flywheel
5. Ring gear
6. Pilot bearing
7. Dowel pins (2)
8. Timing pin

separate outer sealing ring. The seal assembly (1—Fig. 51) is pressed into the front side of the engine rear adapter plate. The outer sealing ring fits around the seal retainer and forms the rear seal for the oil pan.

To renew the rear seal, first remove engine from tractor, then remove the clutch, flywheel, oil pan and engine rear adapter plate. Drive old seal out of adapter plate. Apply gasket sealer to rim of retainer and drive retainer into adapter plate. Apply sealer to exposed rim of retainer and install outer sealing ring; then apply gasket sealer to sealing ring. Complete the reassembly of tractor by reversing removal procedure.

CYLINDER BLOCK

Due to installation procedure for the distributor drive housing or power steering pump dowel pin and also to a production change in the D-17 non-diesel engine which also affects service parts, service procedure information on renewal of the cylinder block was considered necessary. Renewal of the cylinder block on other models does not present any special service problem.

D-17 Non-Diesel

88. When renewing the cylinder block in non-diesel engines prior to engine Serial No. 17-19073, it will be necessary to convert the engine from a by-pass type oil filtering system to a full flow type system. A kit available from Allis-Chalmers parts departments contains a new cylinder block, a high capacity oil pump and a full flow oil filter installation kit. When installing this kit, it is recommended that a new camshaft having a 14-tooth oil pump driving gear and mating 9-tooth oil pump drive gear also be installed. See note after paragraph 90.

When renewing any D-17 non-diesel cylinder block, the following procedure is required: Prior to installing the timing gear cover, install the distributor drive housing assembly (or the power steering pump on power steering equipped models prior to tractor Serial No. D17-42001) and check the backlash of the governor drive gear. If backlash is not within 0.002-0.006, loosen the drive housing or pump mounting bolts and shift the unit until the desired backlash is obtained and re-tighten the mounting bolts. Then, using the drive housing or the pump as a template, use a

1/4-inch drill to drill a hole 3/8-inch deep in the cylinder block. Insert dowel pin and peen edge of hole to secure dowel pin. Then, proceed with reassembly of tractor.

FLYWHEEL

All Engines

89. REMOVE AND REINSTALL. The flywheel can be unbolted and removed after first removing the engine clutch as outlined in paragraph 151 or 152. The non-diesel flywheel is attached to the engine crankshaft with four unequally spaced cap screws and two dowel pins.

Inspect the sealed clutch shaft pilot bearing and renew bearing if rough or noisy. When reinstalling flywheel, tighten the retaining cap screws to a torque of 75 Ft.-Lbs. on non-diesel models and 95-105 Ft.-Lbs. on diesel models.

On D-14 and D-15 models, the starter ring gear can be renewed after detaching (splitting) torque tube from the engine, without removing flywheel from crankshaft. Beveled side of ring gear teeth face toward rear (torque tube).

On D-17 models, the starter ring gear can be removed after removing the flywheel. Beveled side of ring gear teeth face toward front.

OIL PAN (SUMP)

D-14 and D-15 Non-Diesel

90. REMOVE AND REINSTALL. The method of removal is self-evident; however, the two oil pan rear retaining cap screws are slightly longer and should be reinstalled in the proper holes.

D-17 Non-Diesel

91. REMOVE AND REINSTALL. To remove the oil pan, it is necessary to first remove the starting motor and,

on models equipped with power steering, remove the front support unit as outlined in paragraph 13. Then, unbolt and remove the pan from engine. Note: On power steering models, the right front corner of the oil pan may be secured with an Allen head screw located on the top of the cylinder block flange.

When reinstalling pan, thoroughly clean all gasket surfaces, be sure that the pan surface is smooth and true and that the pan arches are 4 3/8 inches across. Use gasket sealer on both sides of gasket and stick gasket to cylinder block. Apply sealer on both sides of arch sealing strips and attach strips to pan arches with metal clips provided in gasket kit; Note: Do not cut off any excess length of gasket end strips, but place strips so that ends extend equally. Push pan straight up against cylinder block, install retaining bolts and tighten to a torque of 12-15 Ft.-Lbs.

Diesel

92. REMOVE AND REINSTALL.

To remove the pan on all diesel models, it is first necessary to remove the front support as outlined in paragraph 13. Front end of pan is retained by cap screws extending through bottom of timing gear cover from front. Unbolt and carefully pry oil pan from engine to avoid damaging gasket flanges on pan.

Be sure that pan gasket surfaces are clean, smooth and true; straighten pan gasket flange if not flat. If gasket between engine front plate and pan was damaged when removing pan, cut lower part of new engine front cover gasket to fit pan. Apply heavy gasket sealer to cut ends of gasket and regular gasket sealer to both sides; stick gasket to engine front plate. Apply gasket sealer to both sides of pan gasket and to seal-

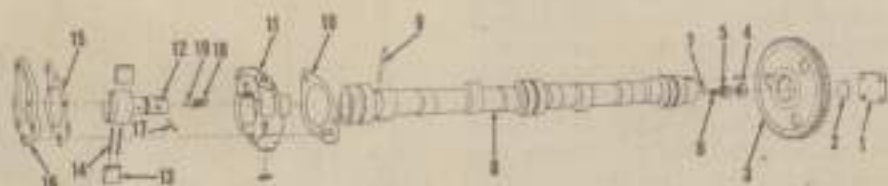


Fig. 52—Exploded view of D-14 and D-15 non-diesel camshaft and oil pump. The pump is driven by pin (19). Some engines are not equipped with check valve parts 17, 18 and 19.

- | | | | |
|--------------------------|------------------------|------------------------|----------------------|
| 1. Camshaft thrust cover | 6. Relief valve spring | 10. Gasket | 15. Gasket |
| 2. Thrust plate | 7. Relief valve ball | 11. Pump body | 16. Pump screw |
| 3. Camshaft gear | 8. Camshaft drive pin | 12. Rotor | 17. Pin |
| 4. Thrust plunger | 9. Oil pump drive pin | 13. Rotor blade | 18. Spring |
| 5. Thrust spring | | 14. Rotor blade spring | 19. Check valve ball |